
anzin
See the Wonders
TAICHI 2025
Workshop
Presenter: Edan Chen
Date: 2025/07/01

- MOEA Value Creation Project @ 2016
- Spun-off from **National Taiwan University (NTU)** @ 2018 Q1

Micro Eye Tracking Technology:
The most easy-to-install eye tracking solution on the market

Ganzin

See the Wonders

Recognized by International Awards

CES INNOVATION AWARDS 2020 HONOREE

XR Golden Awards

Qualcomm® Innovate in Taiwan Challenge

2020 Neo Star

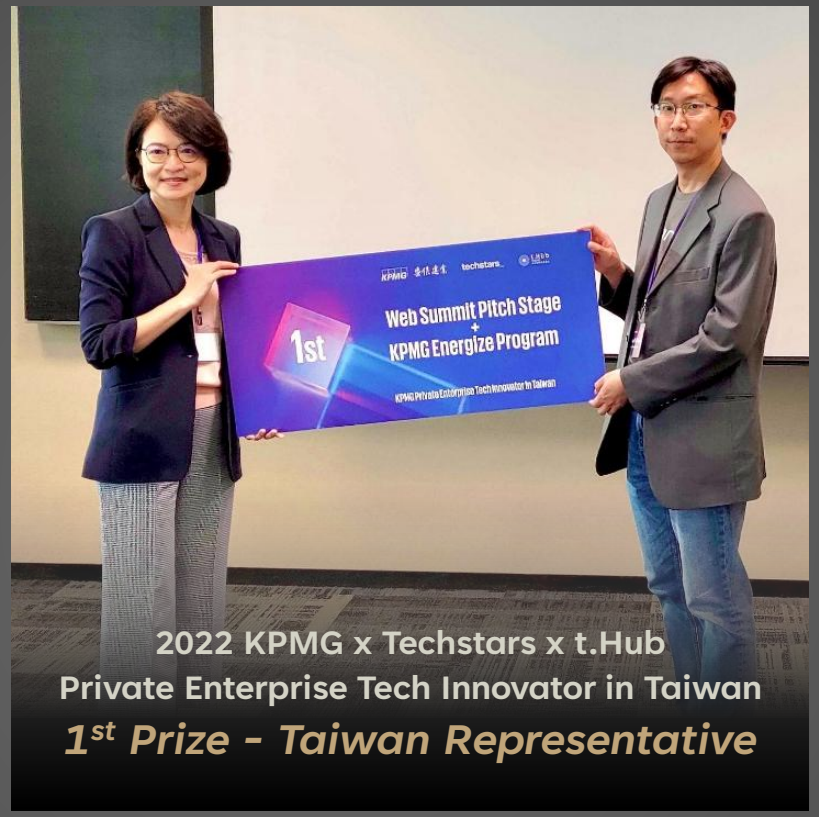
EDISON AWARDS

Milestones @ 2021

- Pre-A round fund-raising @ Q4
- Mass Production of our software solution with integration partners

Awards and Honors

InnoVEX 2022
Taiwania Capital Innovation Award



2022 KPMG x Techstars x t.Hub
Private Enterprise Tech Innovator in Taiwan
1st Prize - Taiwan Representative

Taiwan Innotech Expo
tie Innovation Excellence Award

EDISON AWARDS
INNOVATIONS & INNOVATORS

CES INNOVATION AWARDS 2020 HONOREE

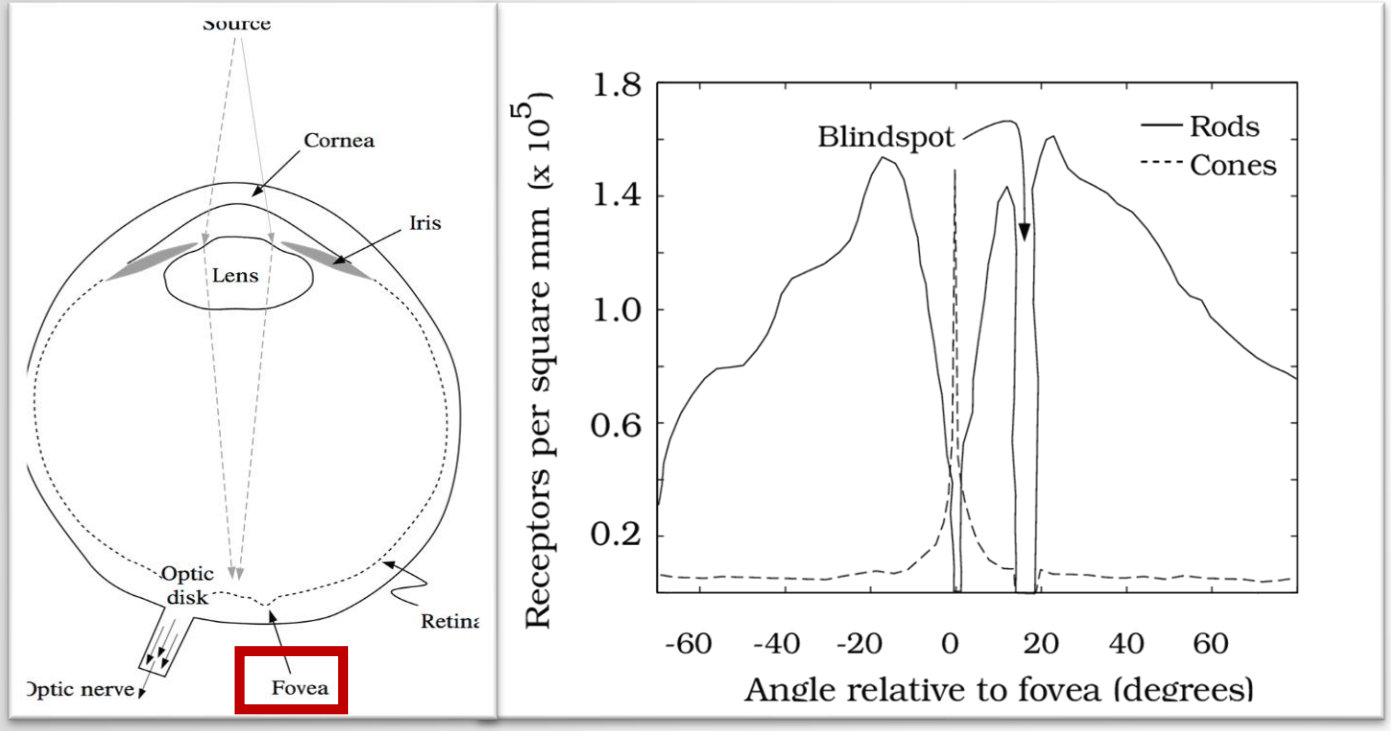
2020 年度最具成長潛力新創 Neo Star

XR Golden Awards
X R 創 星 金 點 大 賞

Qualcomm® Innovate in Taiwan Challenge

Eye-tracking Introduction

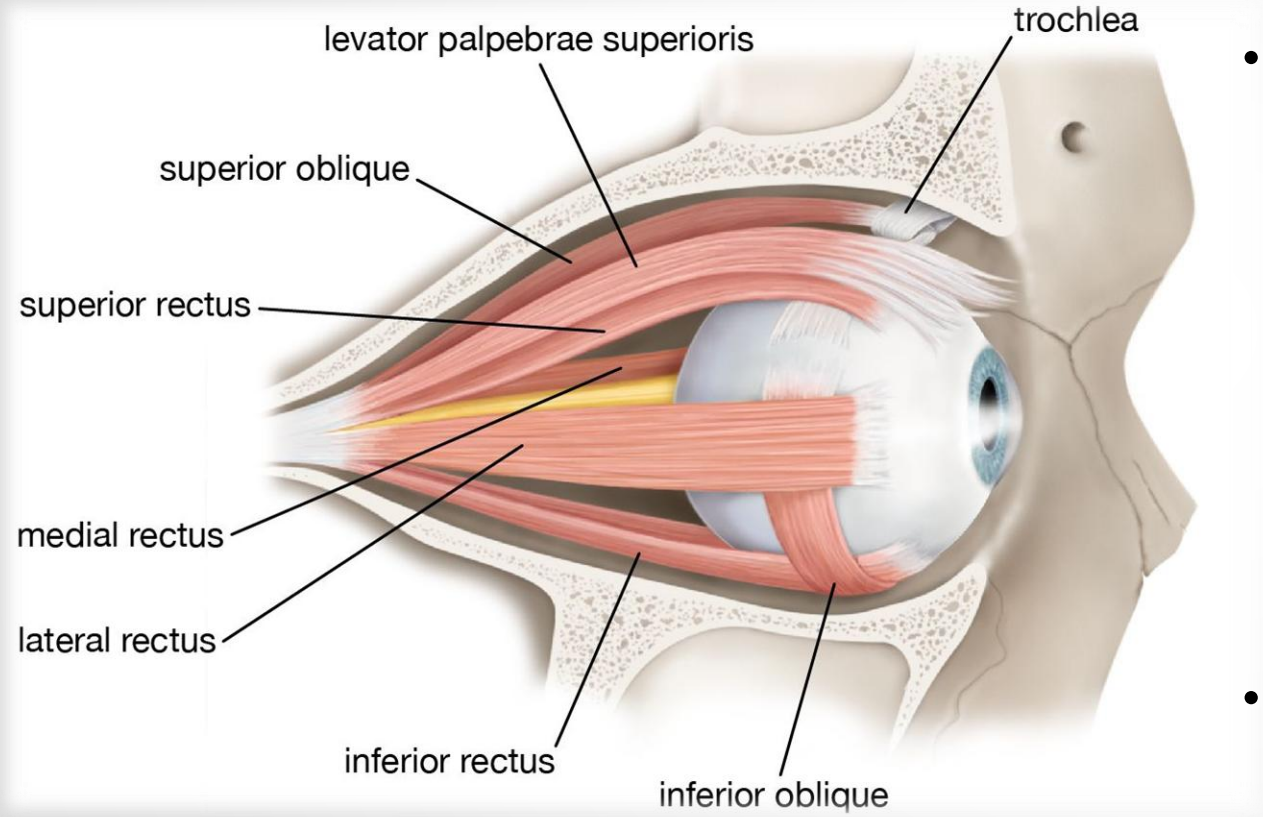
Foveal Vision



Wandell, B. A. (1995)

- **Retinal cones** process high spatial-frequency and color-related visual stimuli
- These cones are densely concentrated in the **fovea**, which is why visual acuity is highest within roughly a **two-degree** visual angle
- In common usage, the term "**gaze**" typically refers to the information received and processed by this region

Extraocular Muscles



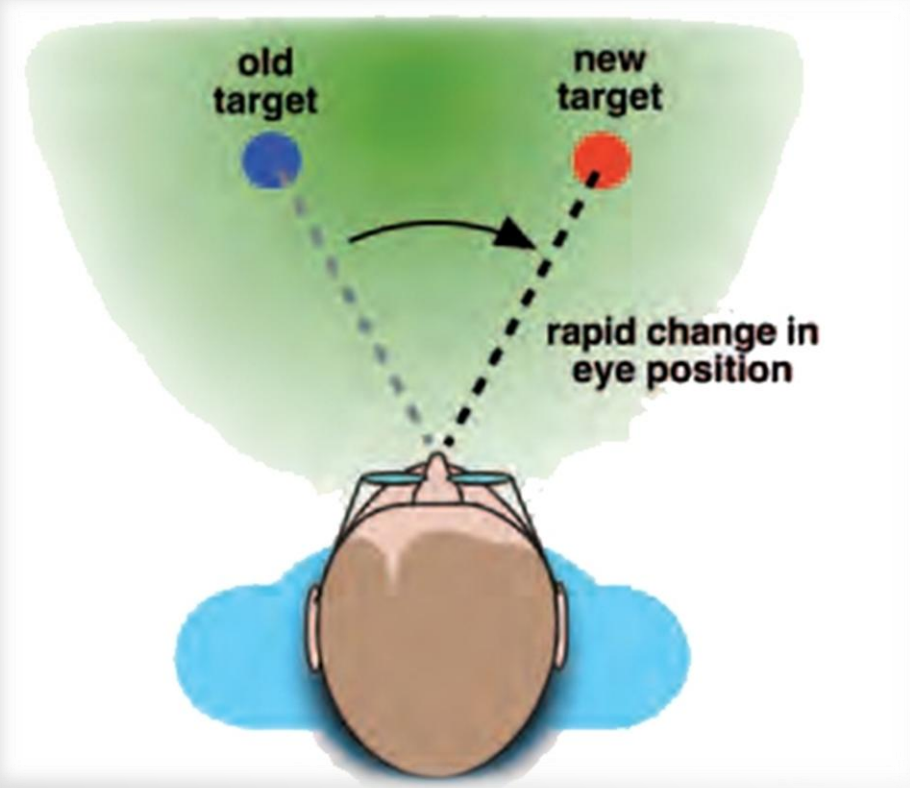
Source: Britannica Inc.

- Ocular muscles and their functions
  - Vertical movements
    - Superior Rectus
    - Inferior Rectus
  - Horizontal movements
    - Medial Rectus
    - Lateral Rectus
  - Torsional movements
    - Superior Oblique
    - Inferior Oblique
- Eyelid opening and closing
  - Levator Palpebrae Superioris

Fixation

- To process specific visual information, the gaze remains on **a particular location for a period of time**
  - keeping that information within the **foveal region** where visual acuity is highest
- Fixation **duration** and **count**
  - The depth of visual processing
  - Indicators of how much **attentional resource** is allocated to a given location.
- Fixation duration can be as brief as a **few tens of ms** or as long as **1000 ms** or more, but it typically clusters around **200–300 ms** (Holmqvist et al., 2011)
- Fixation comprises three types of smaller eye-movement events: drift, tremor, microsaccades

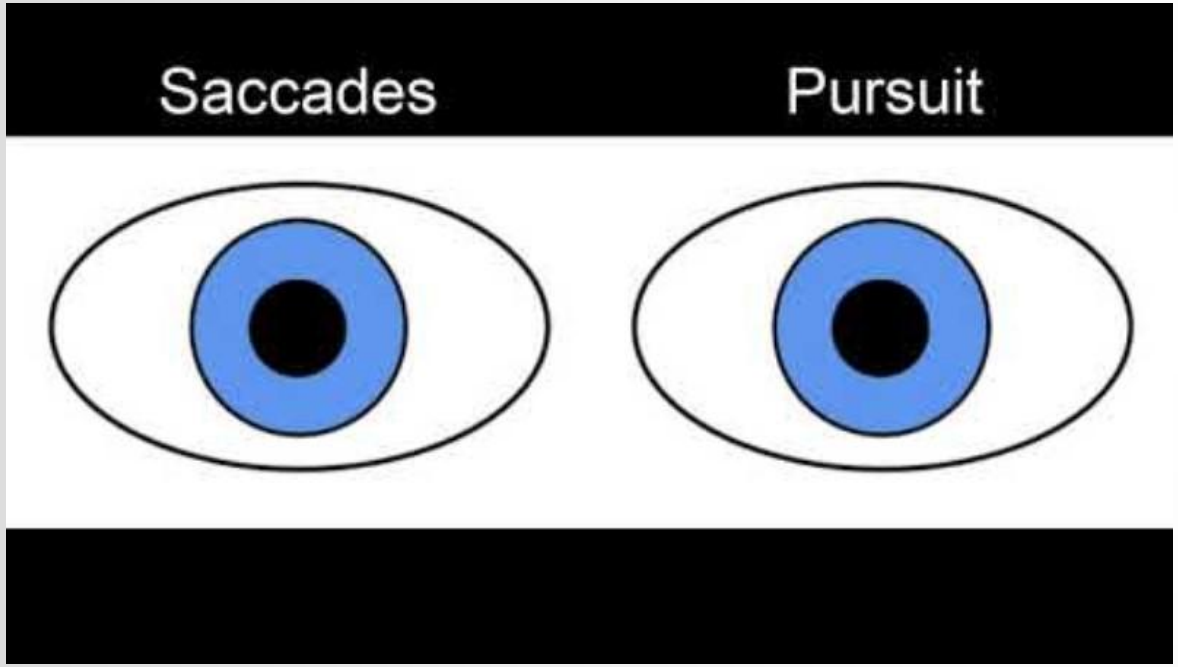
Saccade



Source: https://www.nasafordoctors.co.za/

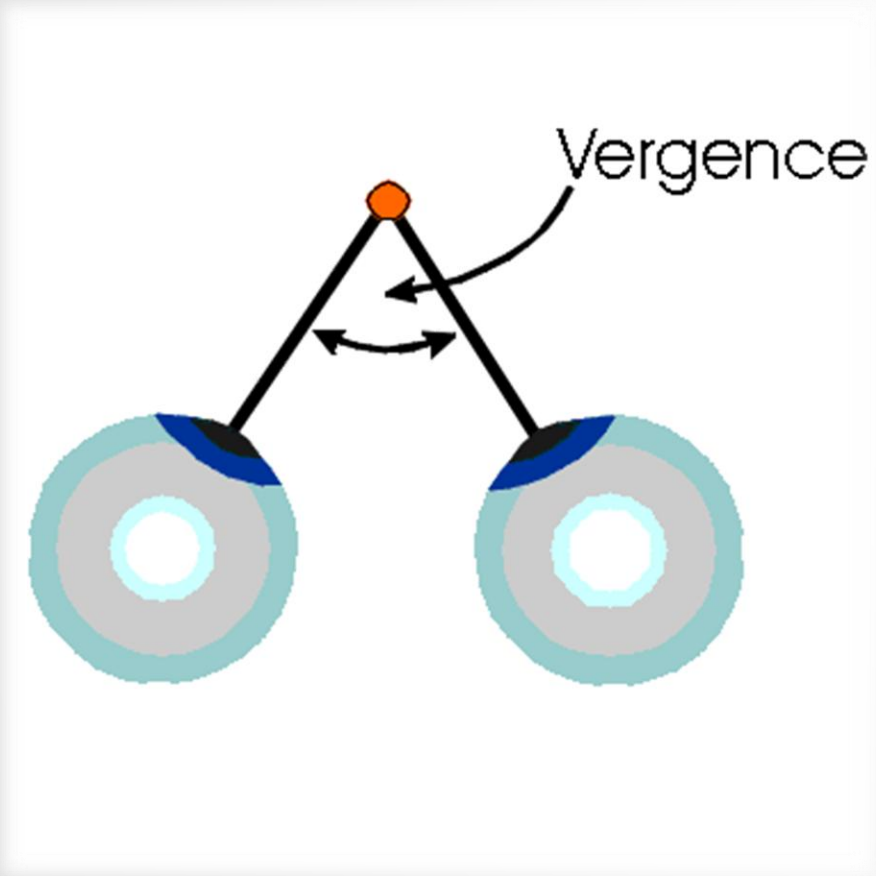
- Saccades are rapid eye movements that shift the gaze between **different fixations**
- The **fastest** and most common type of eye movement
- Saccadic peak velocity ranges from approximately **30°/s** up to over **800°/s** (Zigmond et al., 1999)
- Typical saccade amplitudes fall between **4°** and **20°**, and saccade durations usually range from **30-80 ms**
- Saccade latency—the time required to select the next fixation target and initiate the movement—is typically at least **80 ms**
- Saccadic Suppression Effect
  - During saccades, visual perception is suppressed, rendering the incoming visual information blurred

Smooth Pursuit



- Occur when tracking a **slow-moving** object.
- Pursuit velocities typically range from **10-30°/s**, though individual variability is high; peak velocities can exceed **100°/s** (Zaccara et al., 1991).
- If the target's speed exceeds about 30°/s, observers commonly employ catch-up **saccades** to re-align their gaze with the object (Land & Tatler, 2012).
- Pursuit latency is approximately **100–150 ms** (Bowers et al., 1983).

Vergence



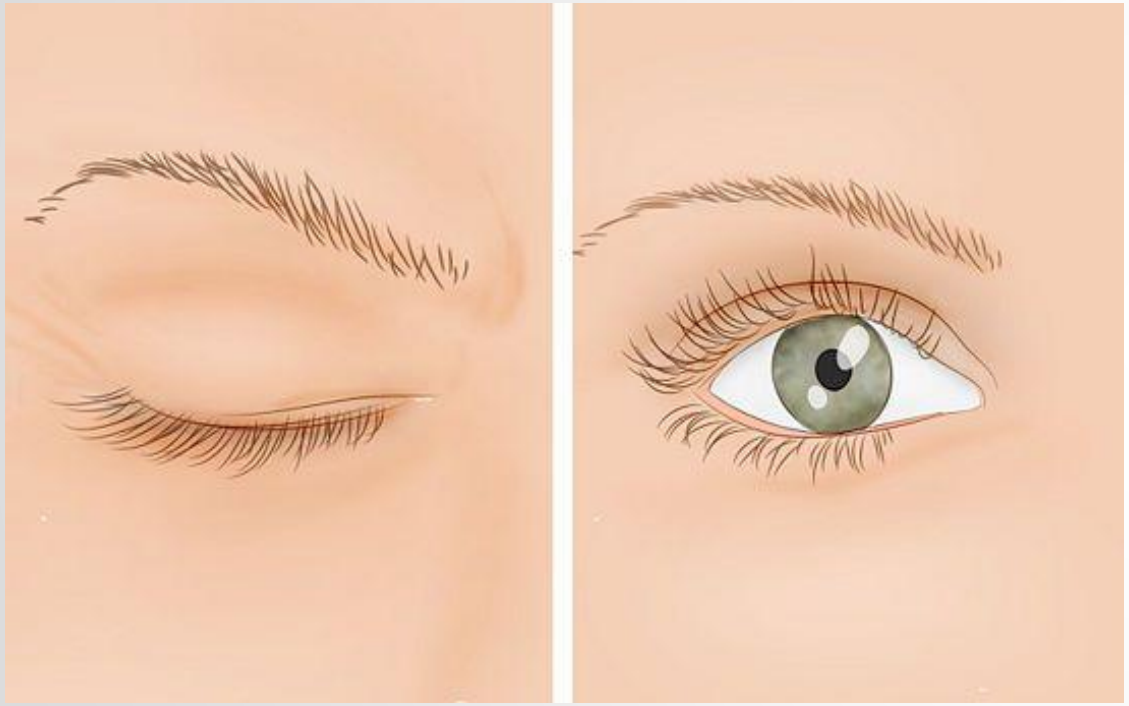
© 1996 Tutis Vilis and Douglas Tweed

- Vergence movements occur when tracking **changes in the depth** of a moving object (Giesel et al., 2019)
  - Convergence (far-to-near): both eyes rotate nasally, toward the nose
  - Divergence (near-to-far): both eyes rotate temporally, away from the nose
- With the exception of vergence, all other eye movements involve both eyes **moving in the same direction**

Vestibular Ocular Reflex, VOR

- When the head turns while maintaining fixation on a specific point, the eyes move involuntarily in the opposite direction to **keep the target stably centered** on the retina
- This is a rapid, unconscious reflex
- Eye-movement velocity matches head-movement velocity (Land & Tatler, 2012)

Blink



Source: 20x20.com

- Although not an eye movement per se, **blink rate** is a frequently used behavioral metric.
- It correlates with **dopaminergic** activity (Karson, 1983).
- It is generally linked **to external attention** and **fatigue** levels (Maffei & Angrilli, 2018):
  - ↑ Attention → ↓ Blink rate
  - ↑ Fatigue → ↑ Blink duration and rate
- Since **dopamine** activity is positively associated with **creativity** (Ashby, Isen, & Turken, 1999), blink rate may also serve as an indicator of **problem-solving ability** (Chermahini & Hommel, 2010).

Pupillometry

Source: Neuroscience News

- Regulated by the **autonomic nervous system**, pupil size serves as a physiological index of **arousal**
- Higher **emotional** arousal is associated with larger pupil diameter (Wang et al., 2017).
- Greater **cognitive effort** likewise produces increased pupil dilation (van der Wel & van Steenbergen, 2018).
- Pupil size is strongly affected by **ambient luminance** (constricting in bright light and dilating in darkness)
  - stimulus brightness must be controlled when investigating cognitive or emotional influences on pupil responses

Summary of Eye-tracking Events

- Fixations and saccades are eye-movement events that are highly associated with cognition and learning (Chen et al., 2010).

Event name	Function / Related Cognitive Processing
Fixation	Visual attention
Saccade	Attentional shift
Smooth Pursuit	Object tracking
Vergence	Depth perception
Vestibular ocular reflex	Compensation for head movements
Blink	Fatigue and attentional state
Pupillometry	Cognitive effort and emotional arousal

References

- 陳學志, 賴惠德, & 邱發忠. (2010). 眼球追蹤技術在學習與教育上的應用. 教育科學研究期刊, 55(4), 39-68.
- Ashby, F., Isen, A., & Turken, A. (1999). A neuropsychological theory of positive affect and its influence on cognition. *Psychological Review, 106*(3), 529-550.
- Bowers, N. R., BoeBahill, A. T., & McDonald, J. D. (1983). Smooth pursuit eye movements in response to predictable target motions. Vision research, 23(12), 1573-1583.hm, A. E., & Roorda, A. (2019). The effects of fixational tremor on the retinal image. *Journal of vision, 19*(11), 8-8.
- Chermahini, S. A., & Hommel, B. (2010). The (b) link between creativity and dopamine: spontaneous eye blink rates predict and dissociate divergent and convergent thinking. *Cognition, 115*(3), 458-465.
- Giesel, M., Yakovleva, A., Bloj, M., Wade, A. R., Norcia, A. M., & Harris, J. M. (2019). Relative contributions to vergence eye movements of two binocular cues for motion-in-depth. Scientific reports, 9(1), 17412.
- Greschner, M., Bongard, M., Rujan, P., & Ammermüller, J. (2002). Retinal ganglion cell synchronization by fixational eye movements improves feature estimation. *Nature Neuroscience, 5* (4), 341–347.
- Hennig, M. H., Kerscher, N. J., Funke, K., & Wörgötter, F. (2002). Stochastic resonance in visual cortical neurons: Does the eye-tremor actually improve visual acuity? *Neurocomputing, 44*– 46, 115–120.
- Holmqvist, K., Nyström, M., Andersson, R., Dewhurst, R., Jarodzka, H., & Van de Weijer, J. (2011). Eye tracking: A comprehensive guide to methods and measures. oup Oxford.
- Kuang, X., Poletti, M., Victor, J. D., & Rucci, M. (2012). Temporal encoding of spatial information during active visual fixation. *Current Biology, 22*(6), 510-514.
- Karson, C. N. (1983). Spontaneous eye-blink rates and dopaminergic systems. *Brain, 106*, 643-653.
- Land, M., & Tatler, B. (2012). *Looking and Acting: Vision and eye movements in natural behaviour*. Oxford University Press.

References

- Maffei, A., & Angrilli, A. (2018). Spontaneous eye blink rate: An index of dopaminergic component of sustained attention and fatigue*. International Journal of Psychophysiology, 123*, 58-63.
- Martinez-Conde, S., Otero-Millan, J., & Macknik, S. L. (2013). The impact of microsaccades on vision: towards a unified theory of saccadic function. *Nature Reviews Neuroscience, 14*(2), 83-96.
- Martinez-Conde, S., Macknik, S. L., & Hubel, D. H. (2000). Microsaccadic eye movements and firing of single cells in the striate cortex of macaque monkeys. *Nature Neuroscience, 3*(3), Article 3.
- Martinez-Conde, S., Macknik, S. L., & Hubel, D. H. (2004). The role of fixational eye movements in visual perception. *Nature reviews neuroscience, 5*(3), 229-240.
- Van der Wel, P., & Van Steenbergen, H. (2018). Pupil dilation as an index of effort in cognitive control tasks: A review. Psychonomic bulletin & review, 25, 2005-2015.
- Wandell, B. A. (1995). *Foundations of vision*. sinauer Associates.
- Wang, C. A., Baird, T., Huang, J., Coutinho, J. D., Brien, D. C., & Munoz, D. P. (2018). Arousal effects on pupil size, heart rate, and skin conductance in an emotional face task. Frontiers in neurology, 9, 1029.
- Zaccara, G., Baldini, S., Gangemi, P. F., Messori, A., Parigi, A., & Nencioni, C. (1991). A new method for analyzing smooth-pursuit eye movements: Description of a microcomputer program and evaluation in healthy volunteers. *The Italian Journal of Neurological Sciences, 12*, 537-544.
- Zigmond, M. J., Bloom, F. E., Landis, S. C., Roberts, J. L., & Squire, L. R. (1999). *Fundamental Neuroscience.* San Diego: Academic Press.

References

- Tobii, (n.d.). *Analyzing the visibility of Earth Corporation's products at the shelf.* https://www.tobii.com/resource-center/customer-stories/analyzing-visibility-of-products-at-the-shelf
- TNS. (2013). *TNS CONVERGENCE MONITOR: TV und Internet profitieren voneinander.* https://www.tns-infratest.com/presse/
- United Internet Media. (2014). *A peek into the living room.* http://united-internet-media.de/en/studies/category-studies/a-peek-into-the-living-room/
- 林如瀚. (2011). 眼動儀在運動視覺控制研究的取向與發展. 中華體育季刊, 25(3).
- Land, Michael F., and Peter McLeod. "From eye movements to actions: how batsmen hit the ball." *Nature neuroscience* 3.12 (2000): 1340-1345.
- Lebeau, Jean-Charles, et al. "Quiet eye and performance in sport: A meta-analysis." *Journal of Sport and Exercise Psychology* 38.5 (2016): 441-457.
- Sáenz-Moncaleano, Camilo, Itay Basevitch, and Gershon Tenenbaum. "Gaze behaviors during serve returns in tennis: a comparison between intermediate-and high-skill players." *Journal of Sport and Exercise Psychology* 40.2 (2018): 49-59.