UNIVERSITÀ DEGLI STUDI FIRENZE

Pulfrich effect

and its applications in optometry

Martina Sostegni

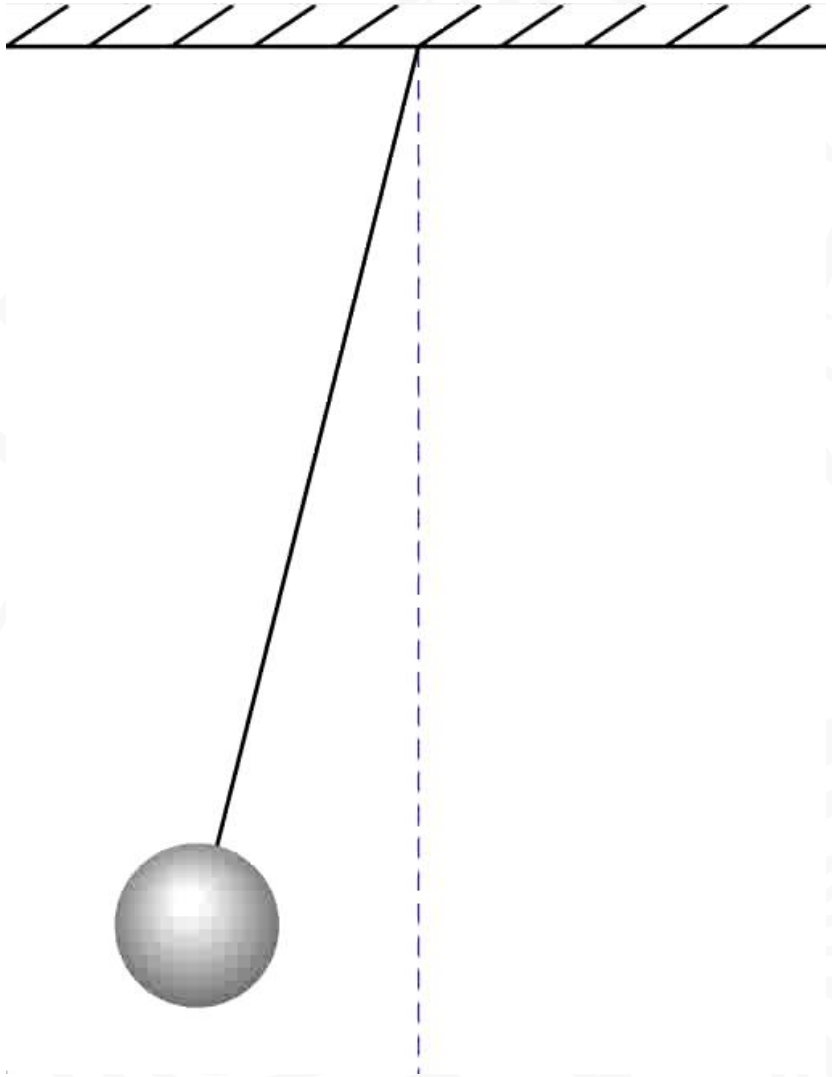
Degree course in Optics and optometry

What is the Pulfrich effect?

The Pulfrich effect is a stereoscopic phenomenon, described for the first time in 1922 by Carl Pulfrich, engineer of the Zeiss' company, who observed it casually while he was using astronomical instruments.

What is the Pulfrich effect?

The effect can be observed by placing a dark filter over one eye, while viewing a pendulum swinging in a plane perpendicular to the observer's line of sight.

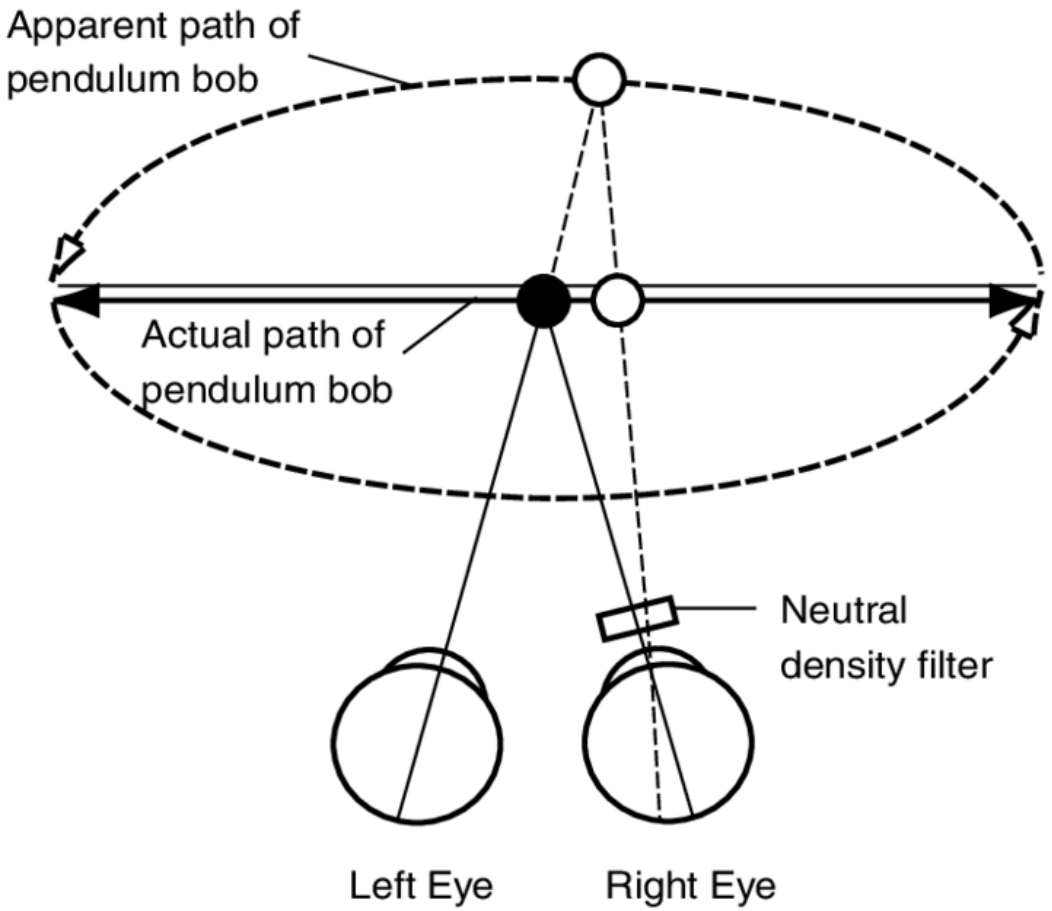


What is the Pulfrich effect?

The reduction in retinal illumination (relative to the fellow eye) yields a corresponding delay in signal transmission.

Thus in the covered eye the perceived position lags a little behind.

Differences in position between the eyes in corresponding retinal locations are interpreted in our brain as different depth.

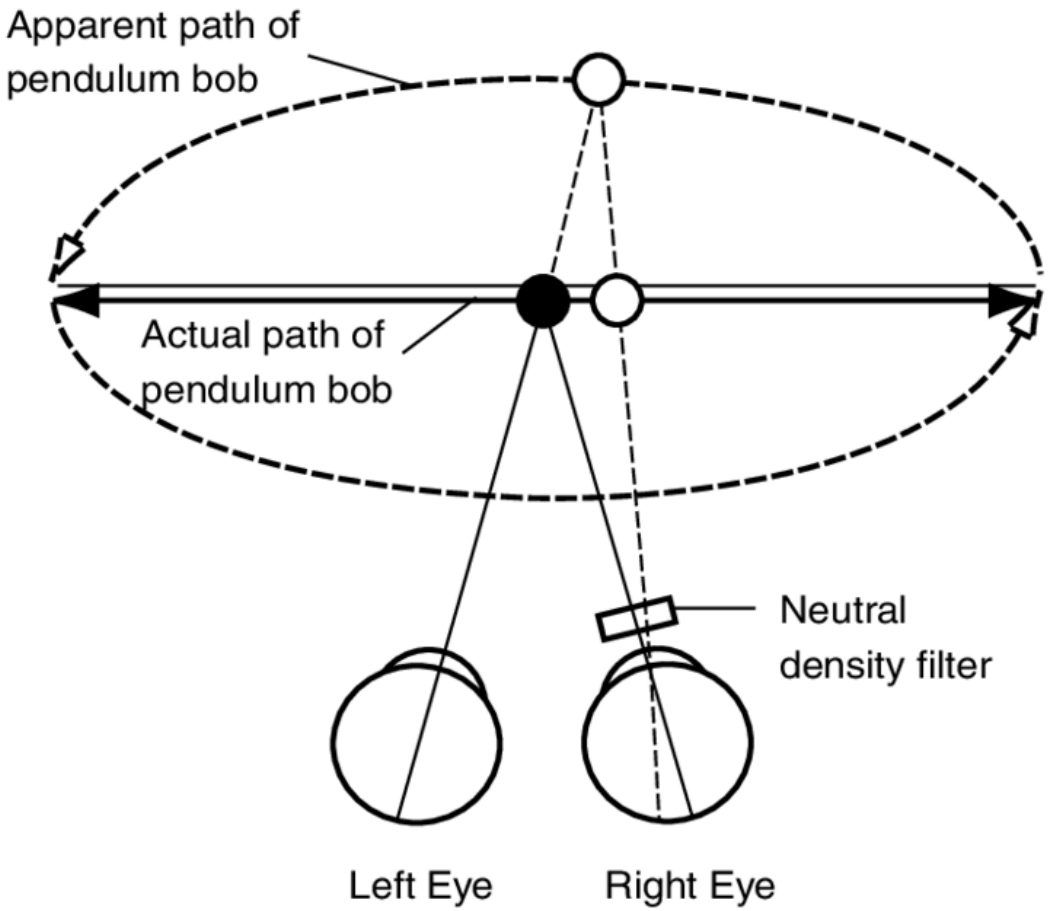


What is the Pulfrich effect?

The result is a stereoscopic 3D effect.

The pendulum seems to take on an elliptical orbit:

- Counterclockwise if the filter is on the right eye.
- Clockwise if the filter is on the left eye.



Pulfrich effect and stereoscopic television

Pulfrich effect can create a 3D illusion for moving images on a television screen.

✗ It doesn’t work on still images.

✔ Without the special glasses, the image is normally seen two-dimensional and unaltered in color, as it happens with anaglyphic glasses (red/green).

Pulfrich effect and stereoscopic television

The Pulfrich effect was used for the whole 1979 anime serie 'Nobody's boy Remi’ (Remi – le sue avventure).

A few days before the first episode, the special glasses were attached to magazines as "Radiocorriere TV" and "TV Sorrisi e Canzoni”.

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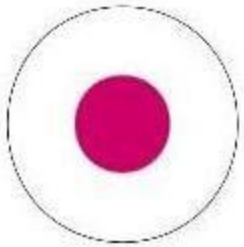
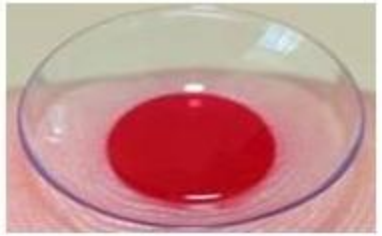
Conditions reported to be associated with the spontaneous Pulfrich effect

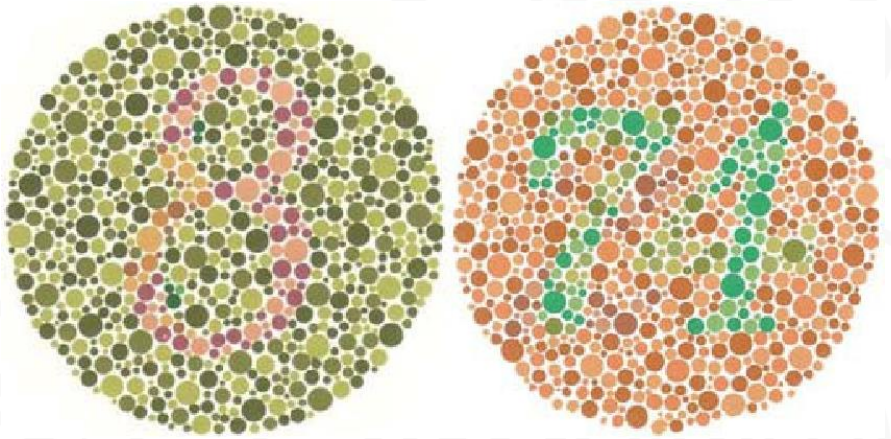
Reducing retinal illumination	Affecting neural conduction	Central pathway conditions
• Unilateral cataract • Corneal opacity • Anisocoria	• Consequences of retinal detachment surgery • Maculopathy	• Optic neuritis • Multiple sclerosis • Hemifacial palsy • Pituitary tumor • Anisometropic amblyopia

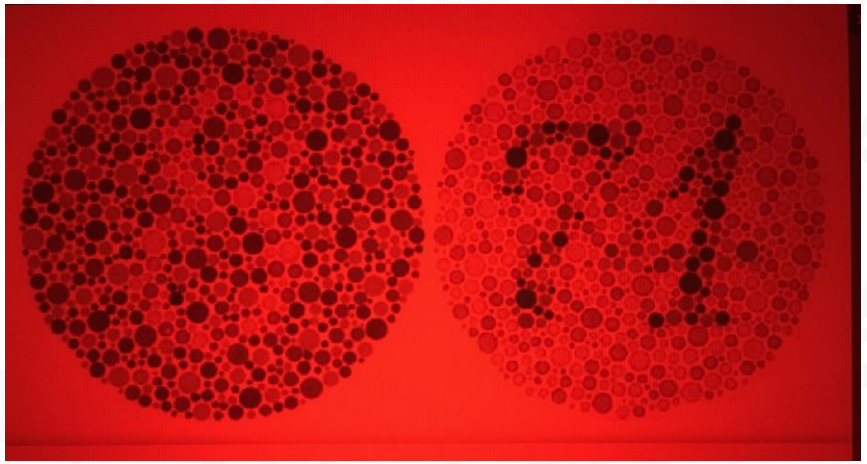
Heng, S., & Dutton, G. N. (2011). The Pulfrich effect in the clinic. Graefe's Archive for Clinical and Experimental Ophthalmology, 249(6), 801-808.

Pulfrich effect caused by the use of contact lenses









Monocular use of X-Chrom o Chromagen™ contact lenses

Pulfrich effect caused by the use of contact lenses

Monovision with contact lenses for the correction of presbyopia:

- dominant eye is corrected for distance vision
- non-dominant eye is corrected for near vision

Rodriguez-Lopez, V., Dorronsoro, C., & Burge, J. (2020). Contact lenses, the reverse Pulfrich effect, and anti-Pulfrich monovision corrections. Scientific reports, 10(1), 1-16.

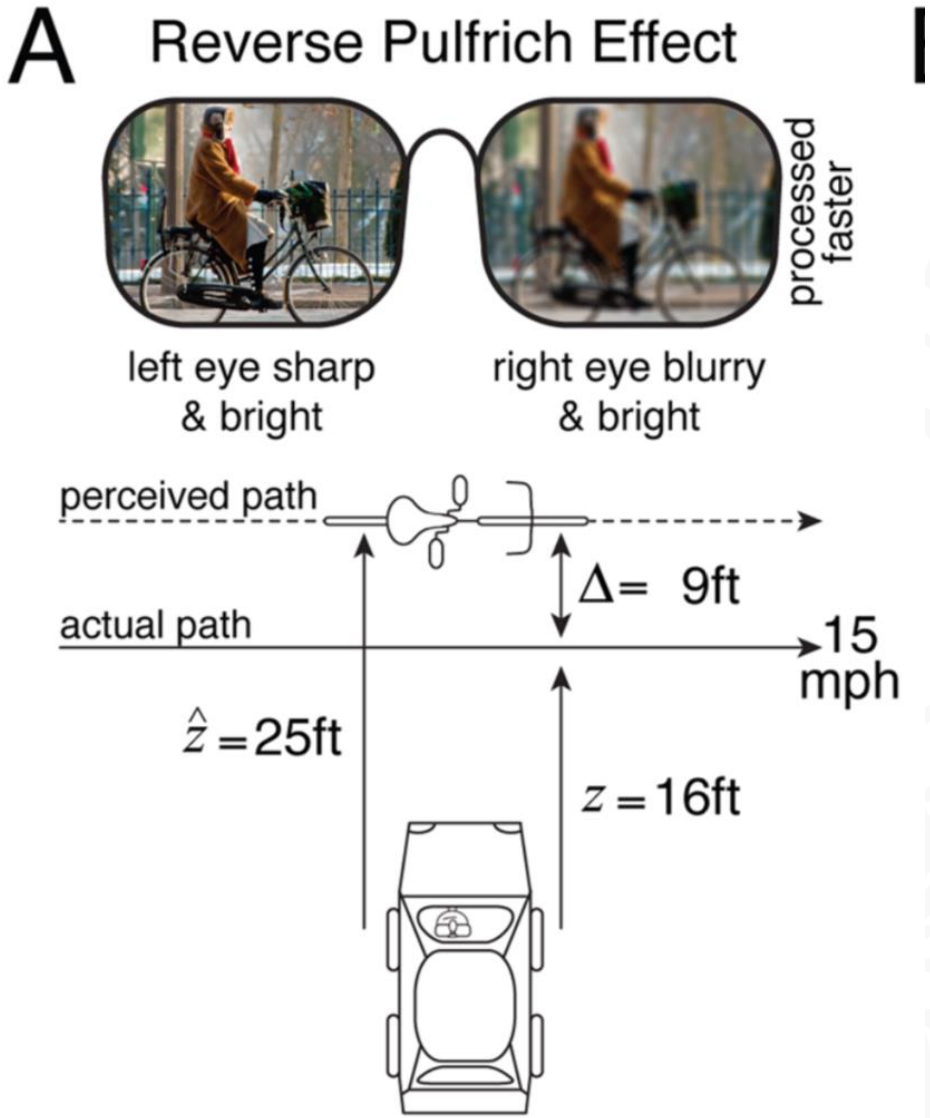
The reverse Pulfrich effect

Monovision correction can cause a misperception of distances:

- Blurry image is processed faster than the sharp image

With a positive lens the image is processed more quickly.

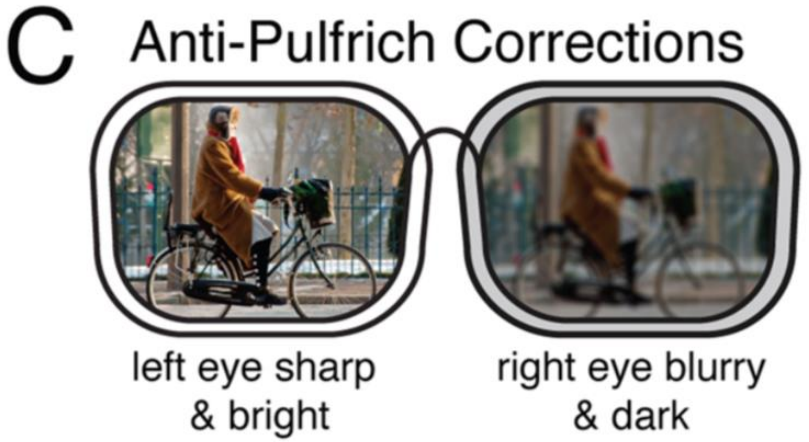
With a dark filter the image is processed more slowly.

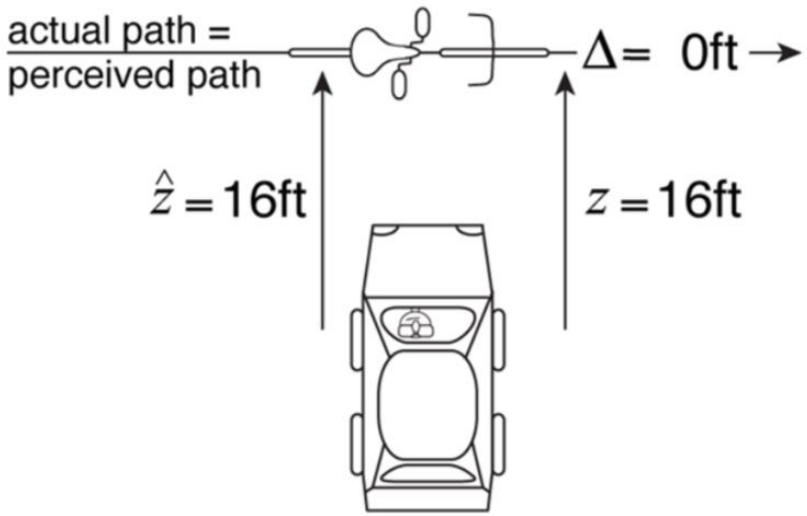


The reverse Pulfrich effect

Darkening the image in the blurrier eye can eliminate the interocular differences in processing speed

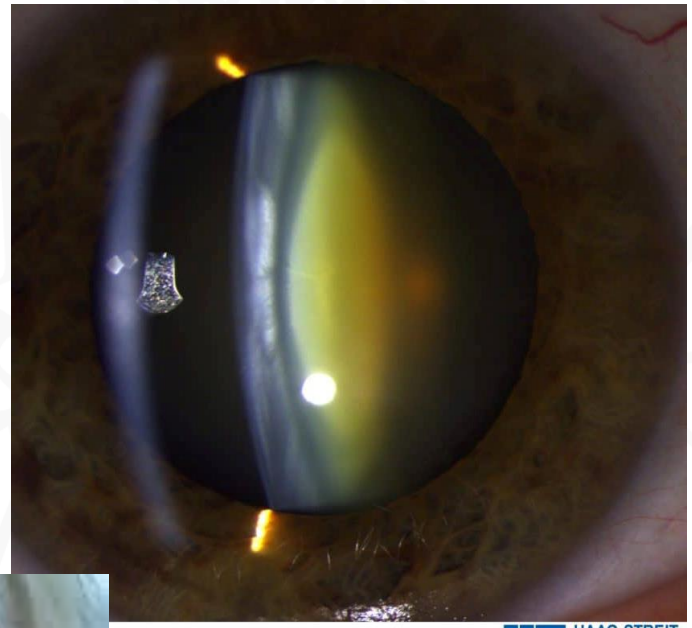
→ Solution: photochromic contact lenses that darken when exposed to outdoor sunlight.





Offsetting of the Pulfrich effect

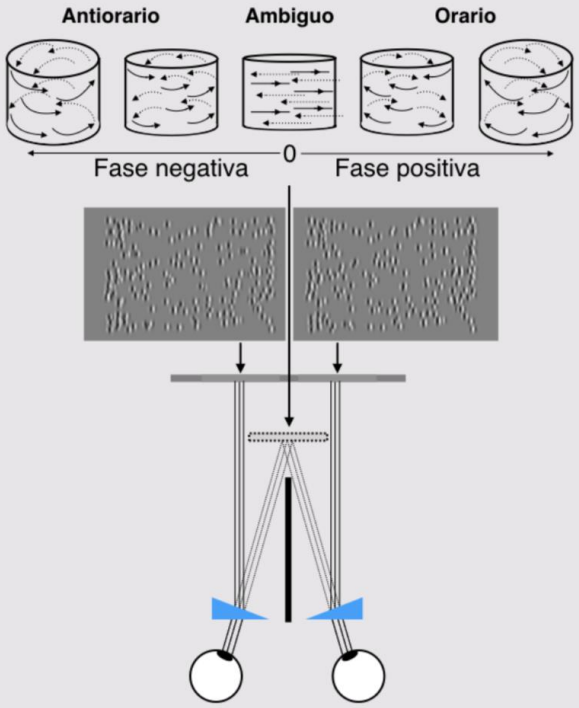
The use of tinted lenses provides a simple, non-invasive and effective treatment option for spontaneous Pulfrich effect.



Color contact lenses ensure a better aesthetic result compared to glasses with only a dark lens.

Pulfrich effect and dominant eye

In optometry the Pulfrich effect can be used to define the dominant eye.



A dichoptic stimulus, used by Reynaud and Hess (2017), was reproduced on a computer, generating the 3D illusory perception of a cylinder rotating clockwise or counterclockwise.

Un test di dominanza oculare su scala continua basato sull'effetto Pulfrich

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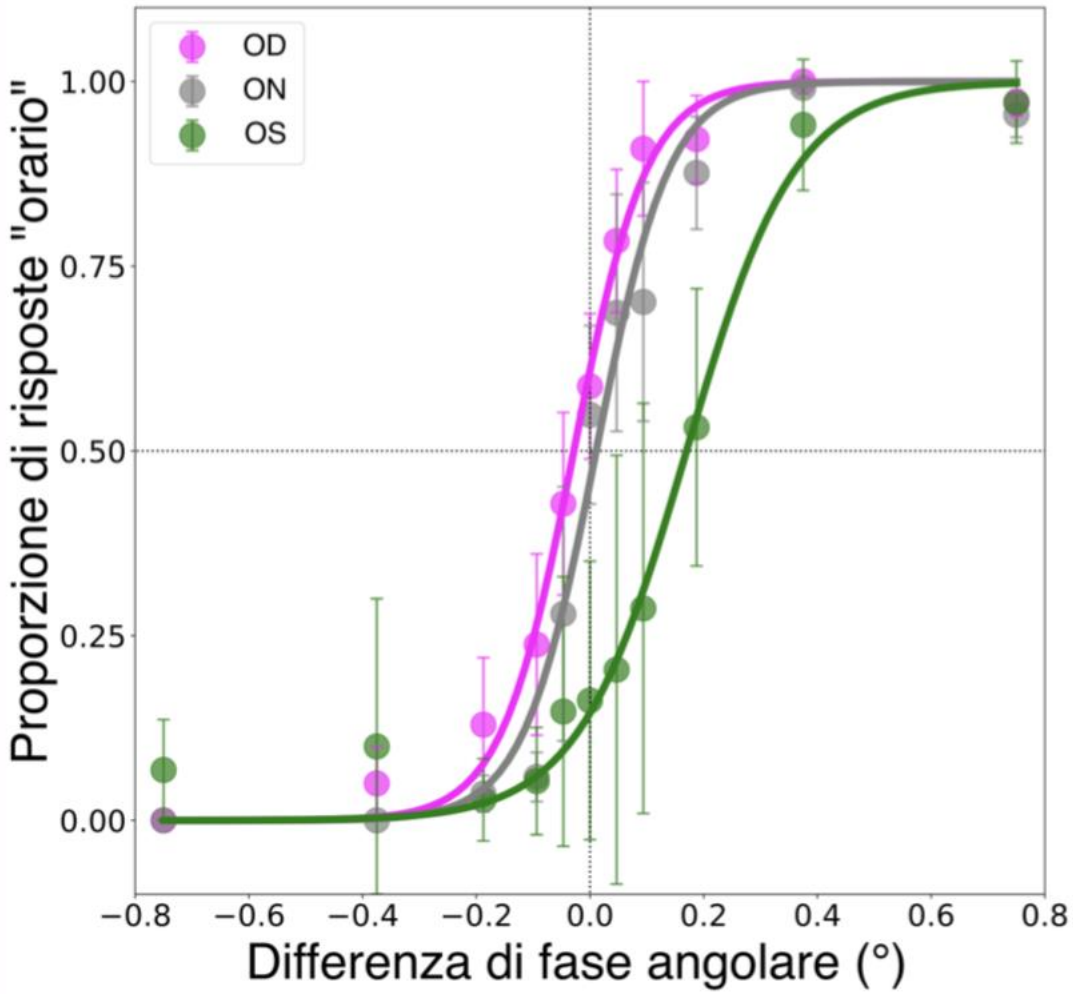
Pulfrich effect and dominant eye

Signals from the dominant eye are processed faster than in the other eye.

Depending on whether the cylinder rotated clockwise or counterclockwise, the dominance was right or left.



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Conclusions

- The Pulfrich effect is a optical illusion that can give the perception of the depth and then a tridimensional vision of moving images.
- It can find application in the evaluation of the dominant eye
- If unintentionally induced, it may cause misperception of the distance and difficulties with motion perception.
- Spontaneous Pulfrich effect may be a sign of monocular disease like optic neuritis, unilateral cataract, or maculopathy.
- The use of dark filters on glasses or contact lenses can solve symptoms related to misperception of distances.

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Thanks you for your attention

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