

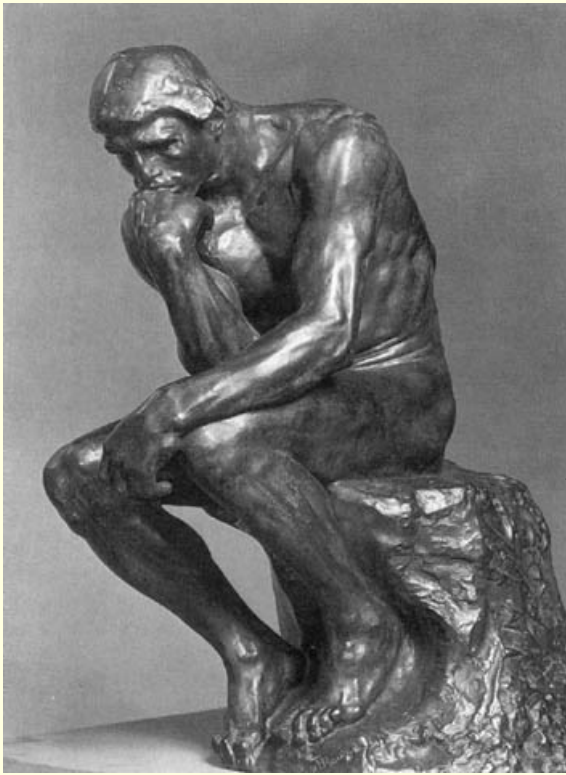
Eye movements and the feeling of presence

Bence Nanay

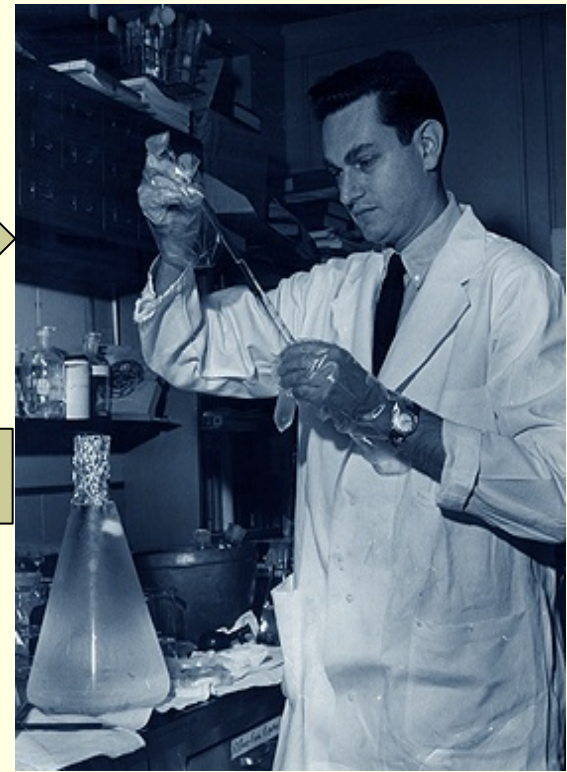
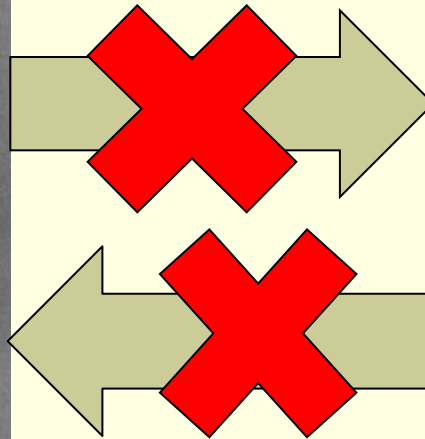
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Philosophy

Traditional philosophical methodology:



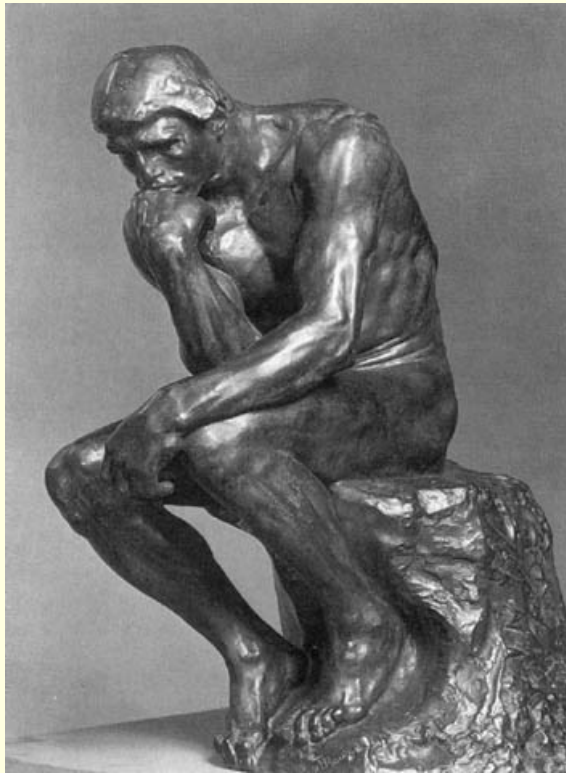
Philosophy



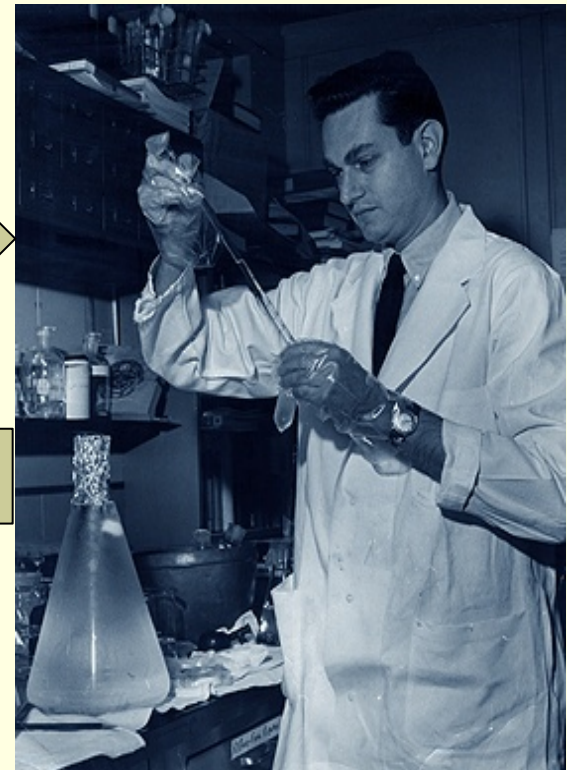
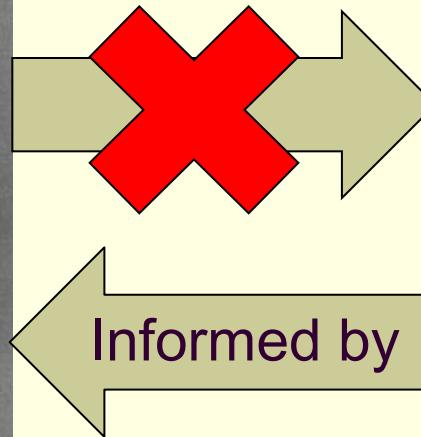
Science

Philosophy

Empirically informed philosophical methodology:



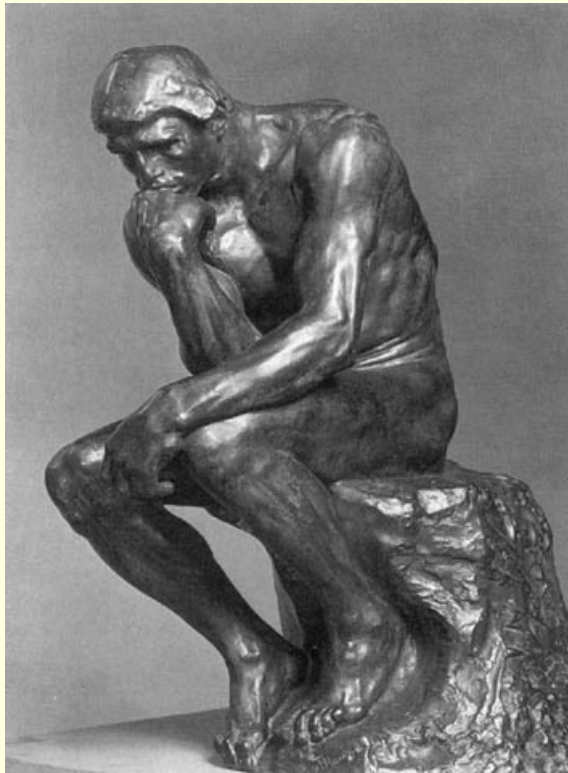
Philosophy



Science

Philosophy

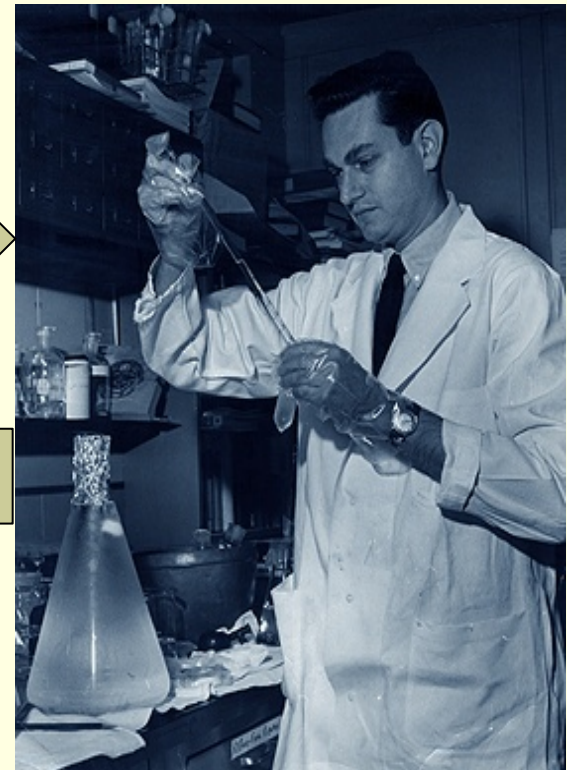
My methodology:



Philosophy

Relevant to

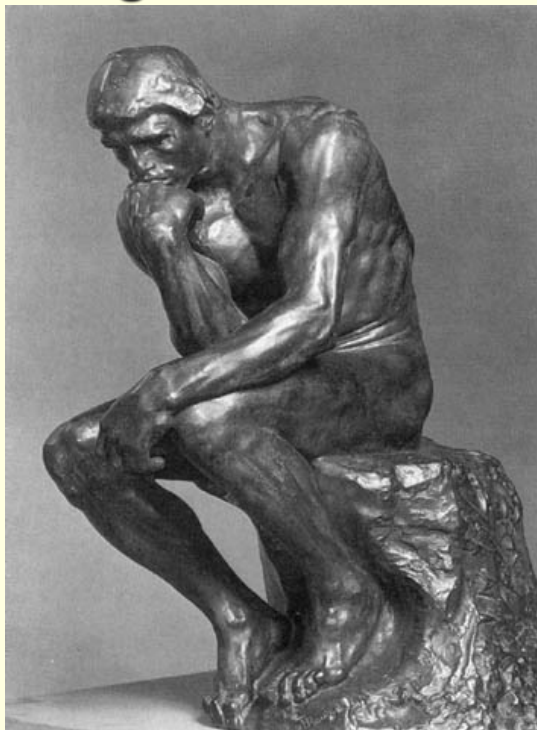
Informed by



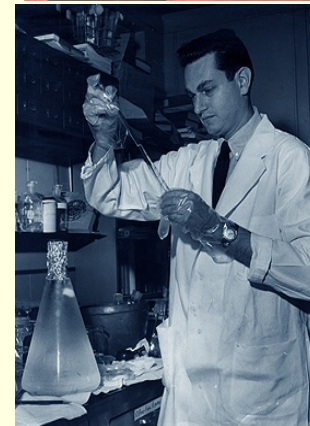
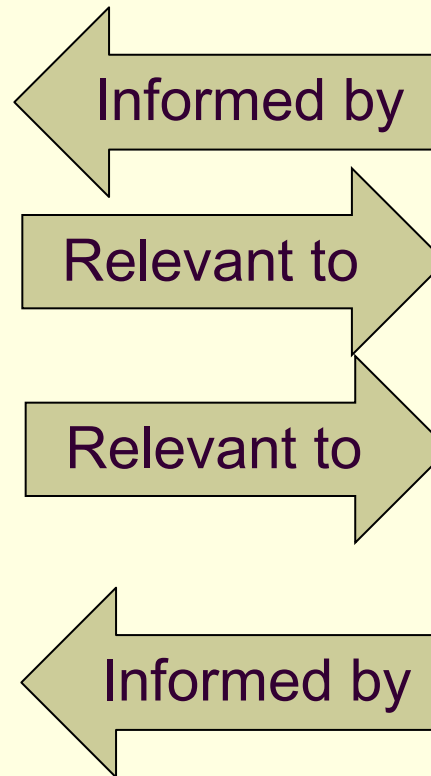
Science

Philosophy

Bringing different scientific subfields together :



Philosophy



Science

OXFORD

MENTAL IMAGERY

PHILOSOPHY, PSYCHOLOGY, NEUROSCIENCE



BENCE NANAY

Mental imagery

Mental imagery: “Visual mental imagery is ‘seeing’ in the absence of the appropriate immediate sensory input,” (Kosslyn, Behrmann, and Jeannerod 1995, p. 1335).

Perceptual processing not directly triggered by sensory input

Mental imagery, just like perception, may be **conscious** or **unconscious**. Also, it may be **voluntary** or **involuntary**. **Egocentric** or **non-egocentric**. And it may or may not be accompanied by the feeling of presence.

VR Research

In VR research, feeling of presence is:

- Essential (Sanchez-Vives and Slater 2005)
- Often the **primary design-goal** (Grassini and Laumann 2020)

Some terminological issues:

- Immersion vs. presence
- Presence vs. feeling of presence

Also in philosophy:

- Feeling of presence vs. Sense of reality (Farkas 2014)

VR Research

“The common view is that presence is the sense of being in a VE rather than the place in which the participant’s body is actually located” (Sanchez-Vives and Slater 2005, p. 333)

“Presence is the sensation of being in the place presented in a VE” (Nash 2000, cited by Grassini and Laumann 2020)

Feeling of involvement (in a task) vs. Feeling of reality (of the virtual objects) (Slater 2009)

Within feeling of reality, distinctions between the reality of physical objects, social actors or self/avatar (Lee 2004)

VR Research

How to measure the feeling of presence in a VE?

- Questionnaires
- Physiological markers (e.g., heart rate)
- Behavioral markers (e.g., virtual cliff)

Serious dissociations!

Something like feeling of immersive presence vs. feeling of motor presence (Barkasi 2021)

My focus: **visual feeling of presence**

Eye movements

Saccades vs. Micro-saccades

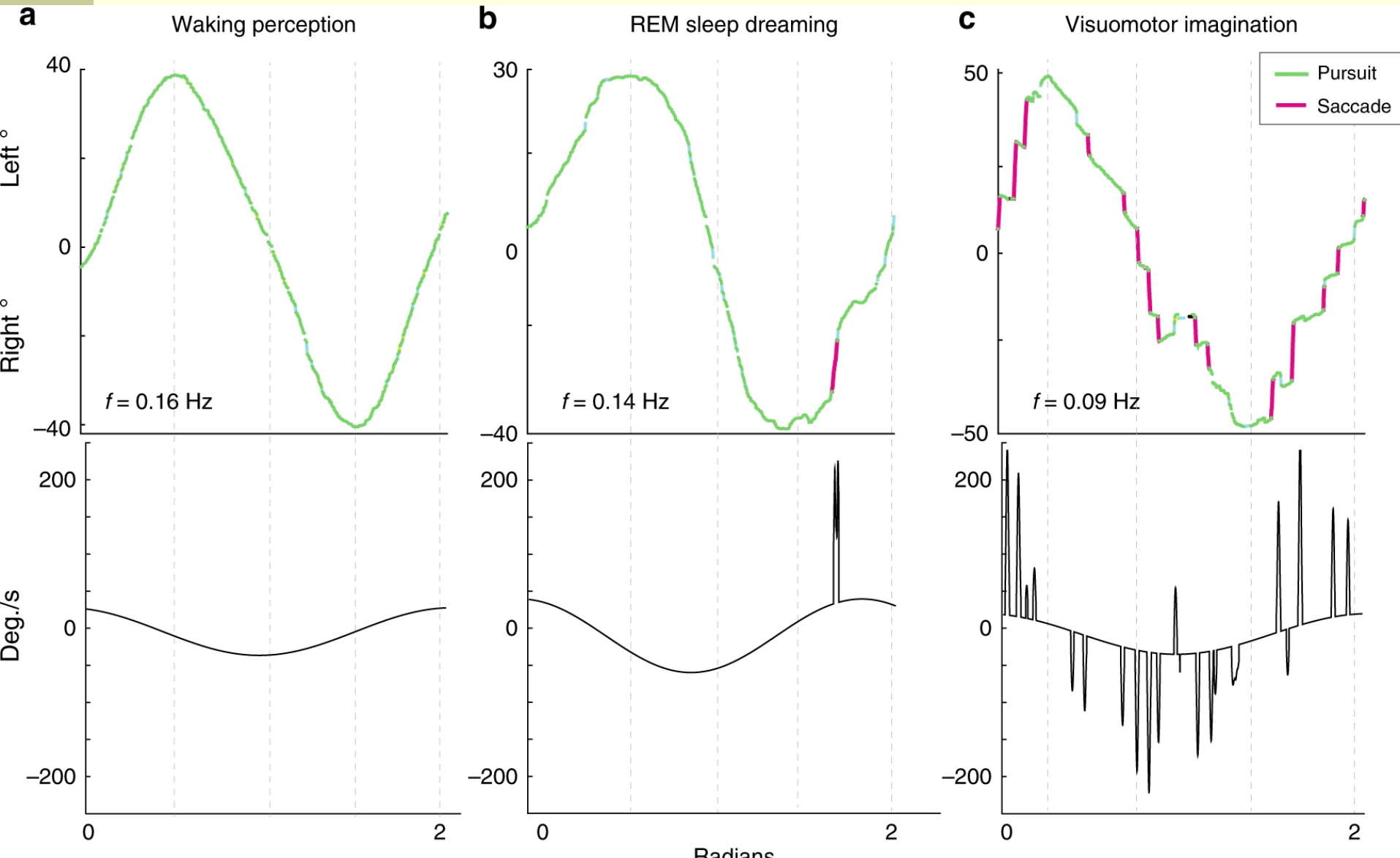
Main result (LaBerge 2018):

Perception: **smooth** tracking of visual objects, small frequent micro-saccades

REM dreaming: **smooth** tracking of visual objects, small frequent micro-saccades

Visualizing: **chunky** (not at all smooth) tracking of visual objects, larger leaps, often supported by voluntary saccades

Eye movements



Eye movements

Perception: smooth tracking. Also feeling of presence

REM dreaming: smooth tracking. Also feeling of presence

Visualizing: chunky (not at all smooth) tracking. No feeling of presence

This is **correlation**, not **causation**. Still...

Some other examples:

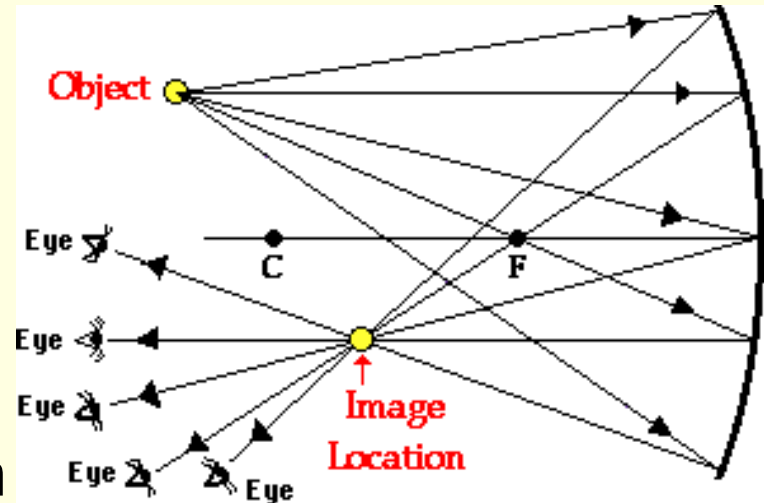
Concave mirrors

Smooth eye movements lead to comparatively **more significant visual change**

This pushes the visual system towards a more than the naturally smooth pursuit

And the phenomenology of seeing an object (or oneself) in a concave mirror is also different – more vivid, more feeling of presence (Casati 2007)

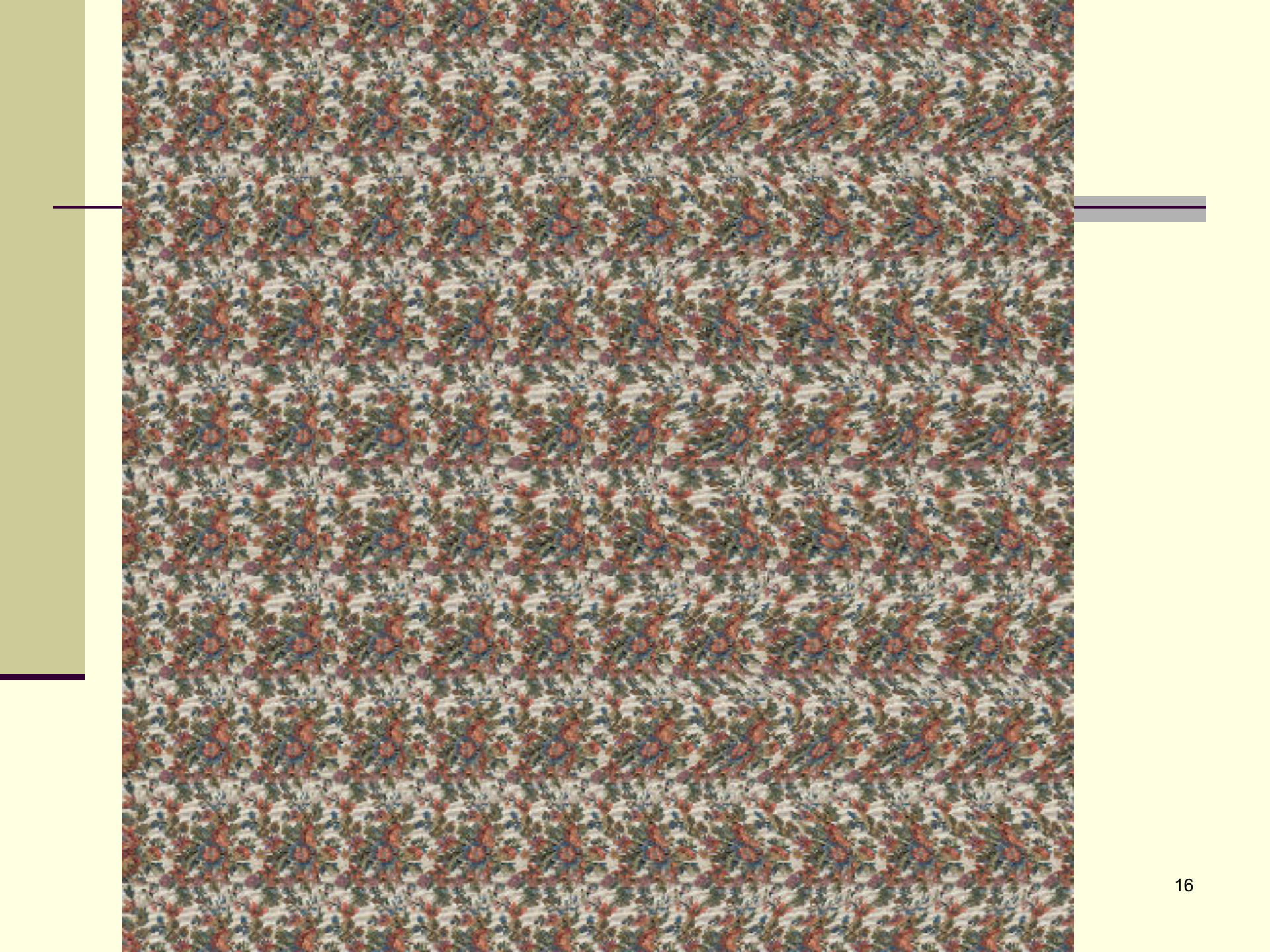
More data points: **Smother tracking correlates with higher level of feeling of presence**



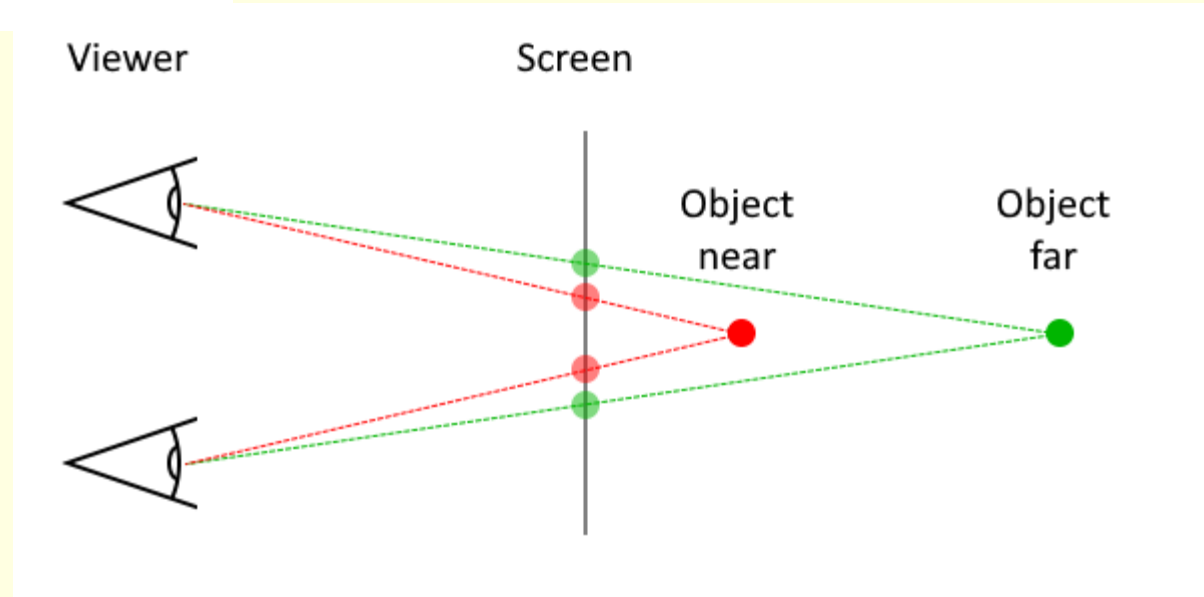
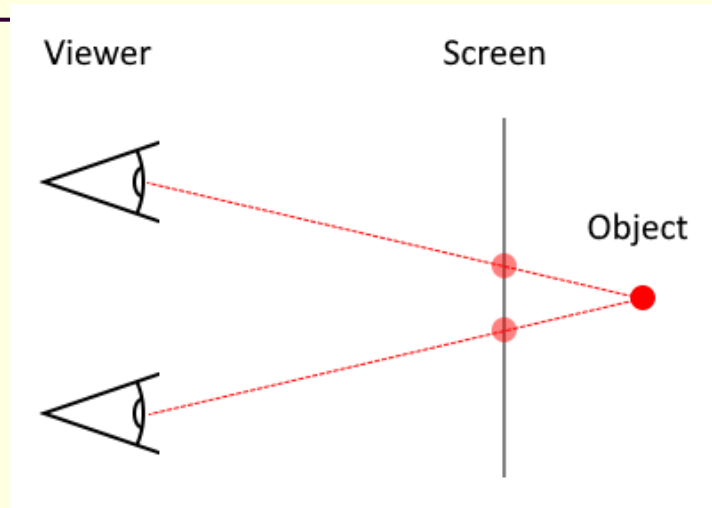
Stereograms

Magic eye pictures, auto-stereograms





How do stereograms work?



Stereograms and feeling of presence

Smooth eye movements lead to comparatively **more significant visual change**

This pushes the visual system towards a more than the naturally smooth pursuit

And the phenomenology of seeing an object (or oneself) in a concave mirror is also different – more vivid, more feeling of presence (Mowforth et al. 1981)

Even more data points: **Smother tracking correlates with higher level of feeling of presence**

Back to VR

Smooth eye movements lead to comparatively **more significant visual change** (hardly surprising given the links to stereogram technique)

This pushes the visual system towards a more than the naturally smooth pursuit

And the phenomenology of seeing an object (or oneself) in a concave mirror is also different – more vivid, more feeling of presence (Khamis et al. 2018, Callahan-Flintoft et al. 2021)

Again: **Smother tracking correlates with higher level of feeling of presence**

Causation vs. Correlation

Smooth tracking and feeling of presence

Perception: **both**

REM dreaming: **both**

Visualizing: **neither**

Convex mirror: both **cranked up** (in comparison to normal perception)

Stereogram: both **cranked up** (in comparison to normal perception)

VR: both **cranked up** (in comparison to normal perception)

Pluralism about feeling of presence

Feeling of presence is **not a monolithic phenomenon** (dorsal stream, sense of reality, etc)

Feeling of presence in VR is not monolithic either (e.g., motor presence vs. immersive presence)

One aspect that has not received much attention has to do with the **visual feeling of presence** and its connection with the **smoothness of tracking eye movements**

But this is just one of many aspects...

Thank you!

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