DIGITAL TRANSFORMATION DIALOGUES

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Accessibility for All

Facilitating Cognitive Engagement with Accessibility Features

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“The power of the Web is in its universality. Access by everyone regardless of disability is an essential aspect.”

Sir Tim Berners-Lee, W3C Director and Inventor of the World Wide Web

Why is it important?

- Access to information and communication, e.g. education, employment, government, commerce, health care
- Positive societal impact,
  equal opportunity
- Legal and ethical responsibility, e.g. Americans with Disabilities Act, European Accessibility Act
- Improved user experience for all

https://www.w3.org/WAI/fundamentals/accessibility-intro/

how **accessible content** impacts **user experience**

Background & Motivation

- Web accessibility in individuals without disabilities (Campoverde-Molina et al., 2020; Schmutz et al., 2017; Zhang et al., 2017; Sonderegger et al., 2018; Vollenwyder et al., 2018; Yesilada et al., 2011)

- **Motivation**: Examining the cognitive engagement experienced by **users without disabilities** when interacting with web pages of varying accessibility levels using physiological measures.

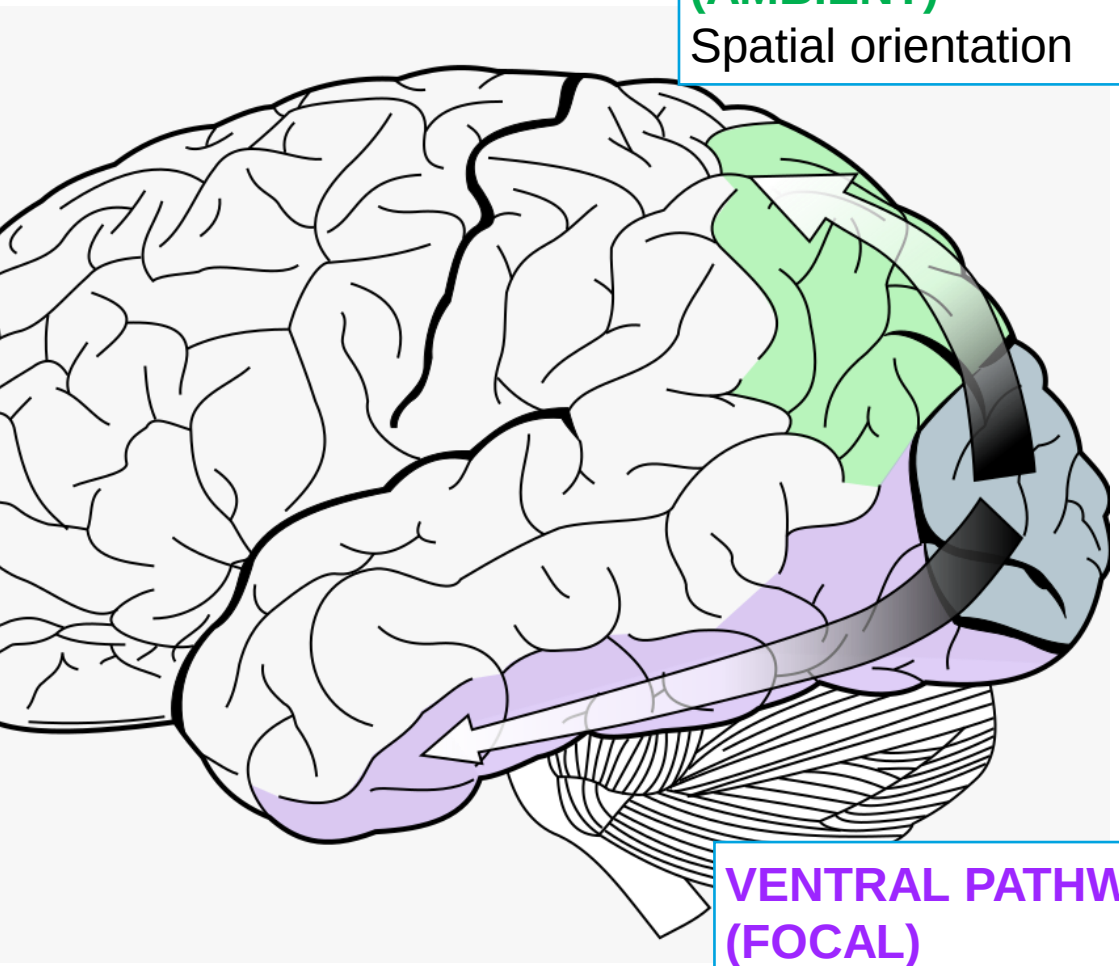
Digital media constantly fights for our attention

but

information acquisition requires focal attentive processing for a relatively long time

Focal Processing ⟷ Cognitive Engagement

Cognitive engagement and visual attention



DORSAL PATHWAY (AMBIENT)
Spatial orientation

VENTRAL PATHWAY (FOCAL)
Visual identification

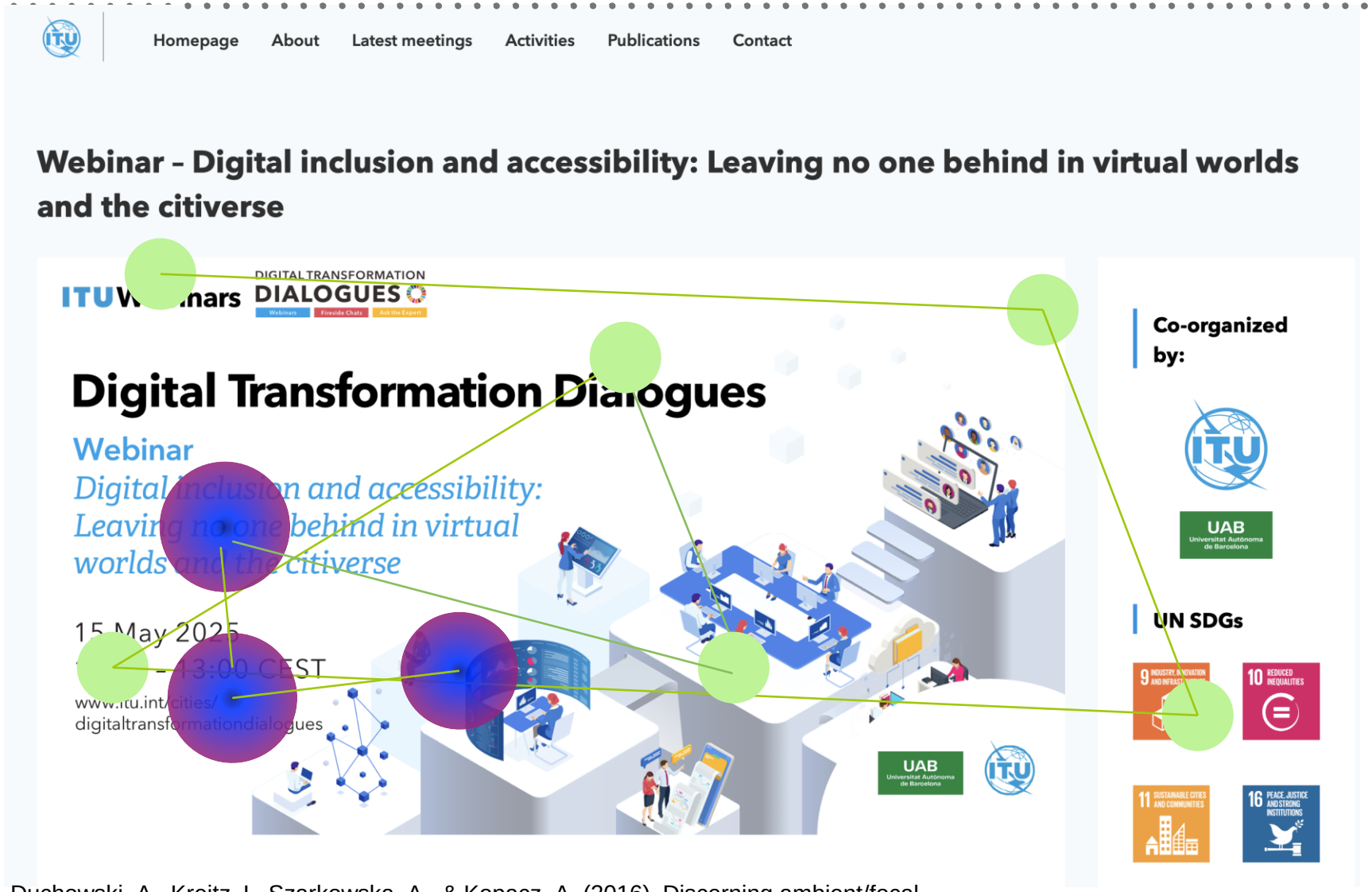
Cognitive Engagement: Allocation of cognitive resources for information processing (Clinton-Lisell et al., 2024)

Visual attention is a constant interplay of two main processing modes (Pannasch et al., 2008; Unema et al., 2005; Krejtz et al., 2016)

- **Ambient**: skim of the visual field with no cognitive costs
- **Focal**: detailed processing of information in the central vision with significant cognitive resources allocation - deep cognitive engagement

Image source: https://en.wikipedia.org/wiki/Two-streams_hypothesis#/media/File:Ventral-dorsal_streams.svg

AMBIENT - FOCAL eye movements



$$\mathcal{K}_i = \frac{d_i - \mu_d}{\sigma_d} - \frac{a_{i+1} - \mu_a}{\sigma_a}$$

$$\mathcal{K} = \frac{1}{n} \sum_{n} \mathcal{K}_i$$

Krejtz, K., Duchowski, A., Krejtz, I., Szarkowska, A., & Kopacz, A. (2016). Discerning ambient/focal attention with coefficient K. *ACM Transactions on Applied Perception (TAP)*, *13*(3), 1–20. https://doi.org/10.1145/2896452

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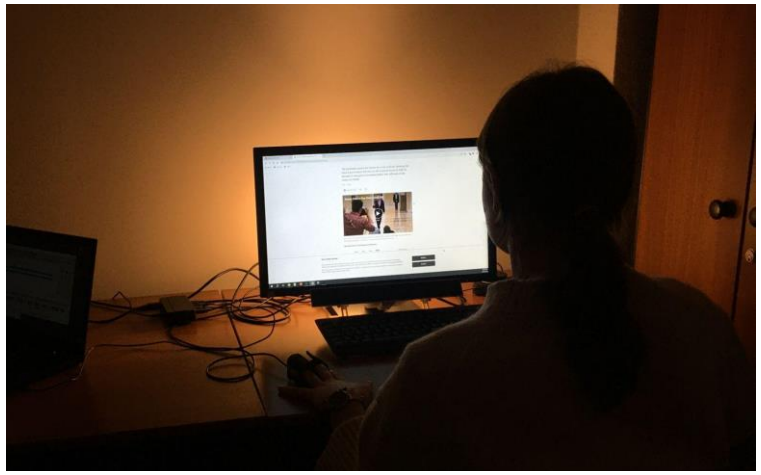
User Study



Sample:
20 (12F, age 26.65 ± 6.98) English-speaking social science students

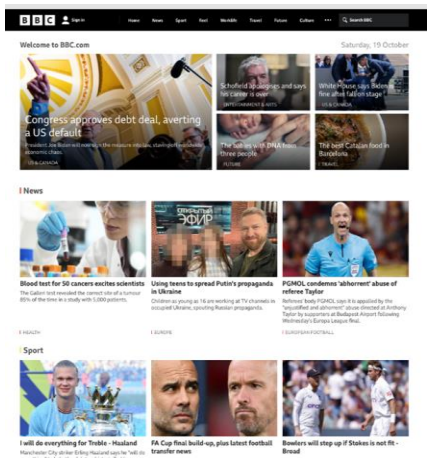
Apparatus:
Eye Tracker / Biometrics / Finger Sensor Module (150Hz)

Study materials:

News websites with accessibility enhancements

1. Low vision
2. Cognitive impairment accessibility

- Applied to websites that already have a very good level of accessibility



WCAG

User study method

Subjective assessment:

- Context comprehension questions
- Web page readability
- Web page comprehension

Eye Metrics:

- K-coefficient
- Number of fixations
- Average fixation duration
- Total fixation time

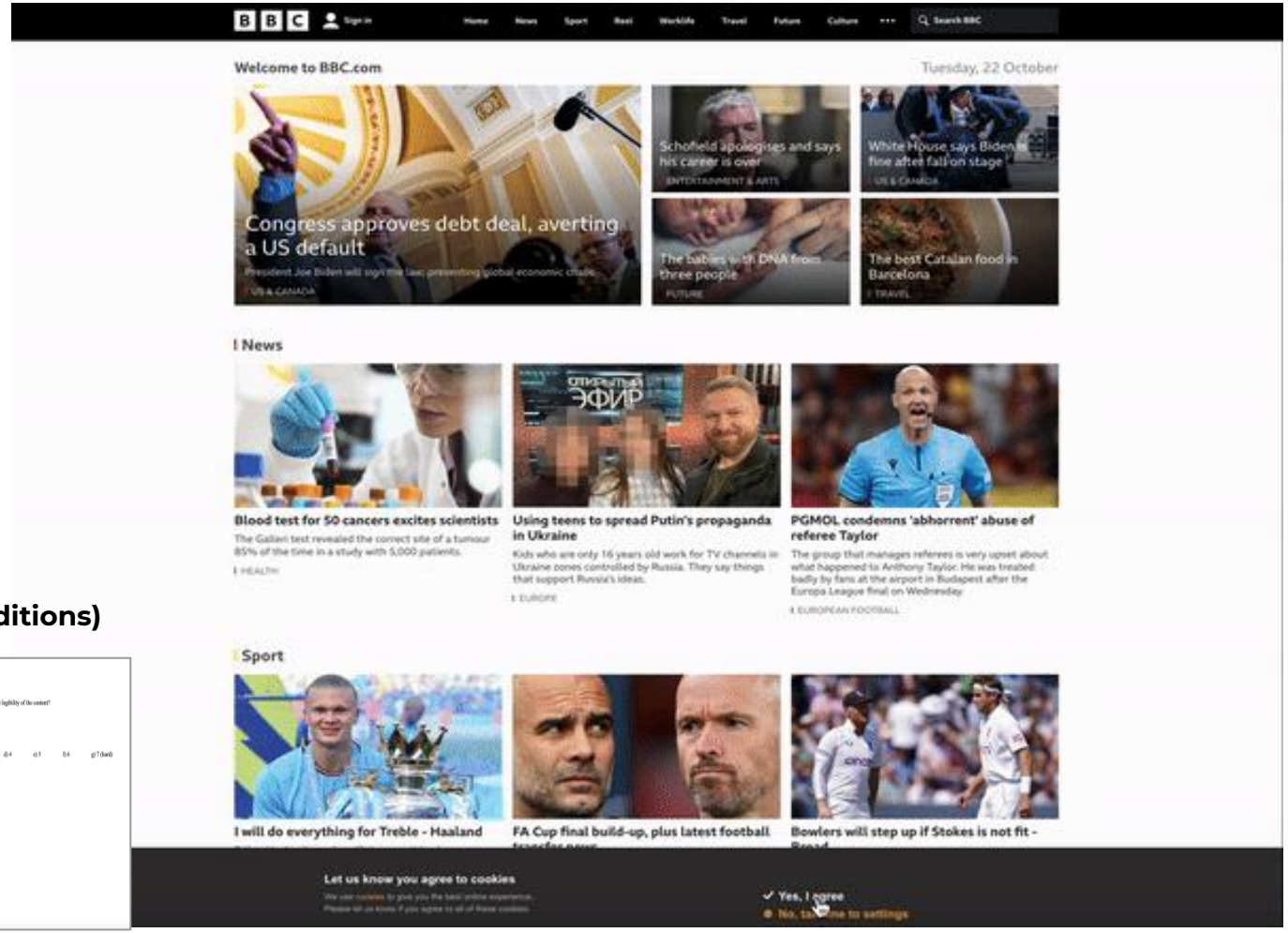
Bio-metric:

- Length of heart IBIs
- Heart rate variability

Experimental procedure

Web Page Task

- scroll the website,
- read article,
- click the articles



Physiological measure part
(Within Subject Design: Each participant repeats this for 8 conditions)

Web Page (60 s)

Comprehension question (45 s)

Understandability question (15 s)

Readability question (15 s)

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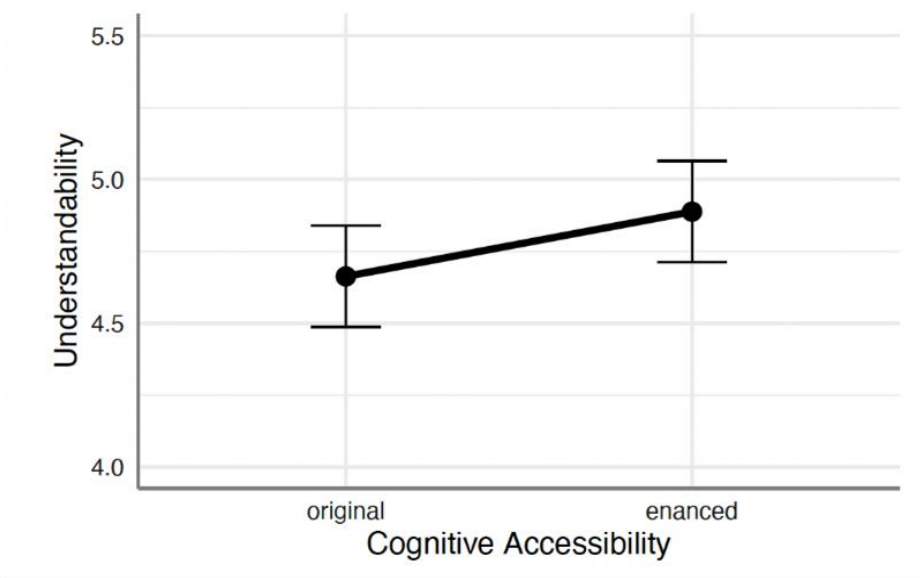
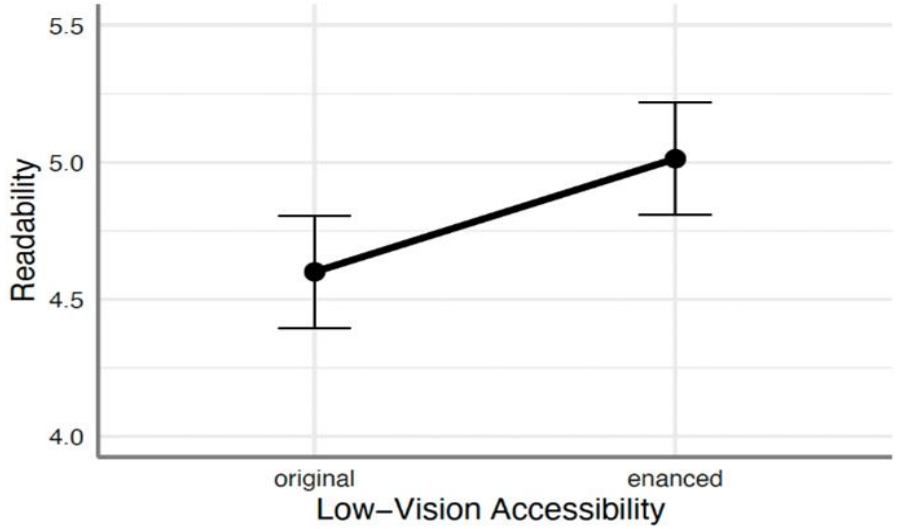
Study results

Self reports: understandability & readability

H1: **Users' evaluations of content understandability and readability** reflect the differences between websites' original and enhanced accessibility features.



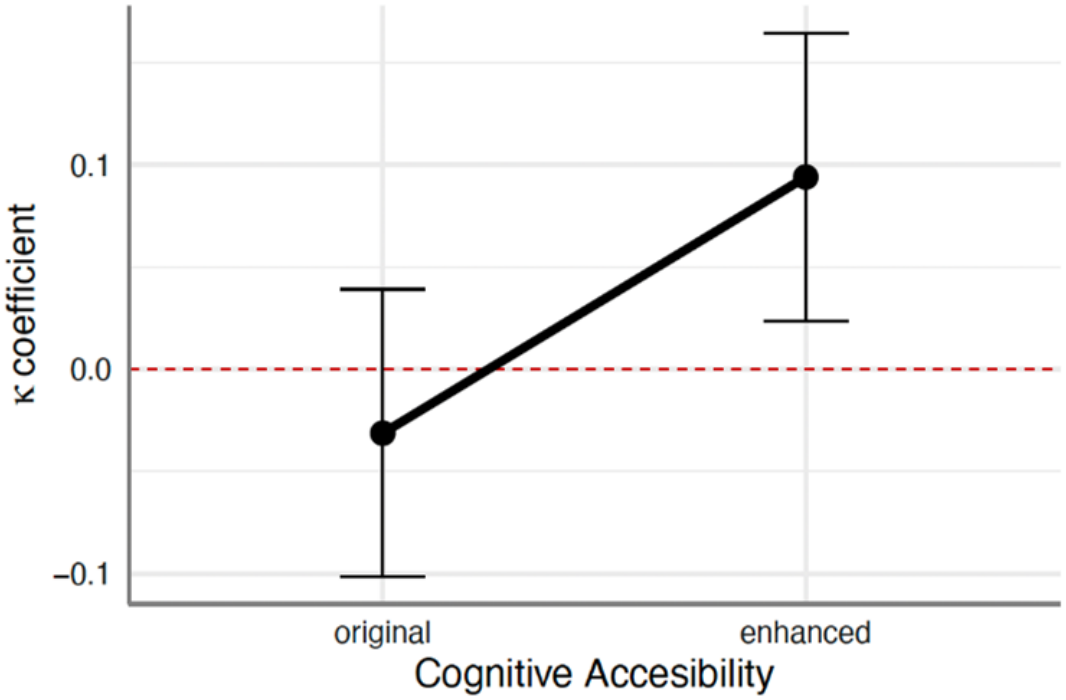
Cognitive accessibility enhancements
>> high understandability



Low-vision accessibility enhancements
>> high readability

Study results
Eye metrics: Attention focus

H2: The differences **in visual attention focus between the original and enhanced websites** are due to cognitive accessibility enhancements.



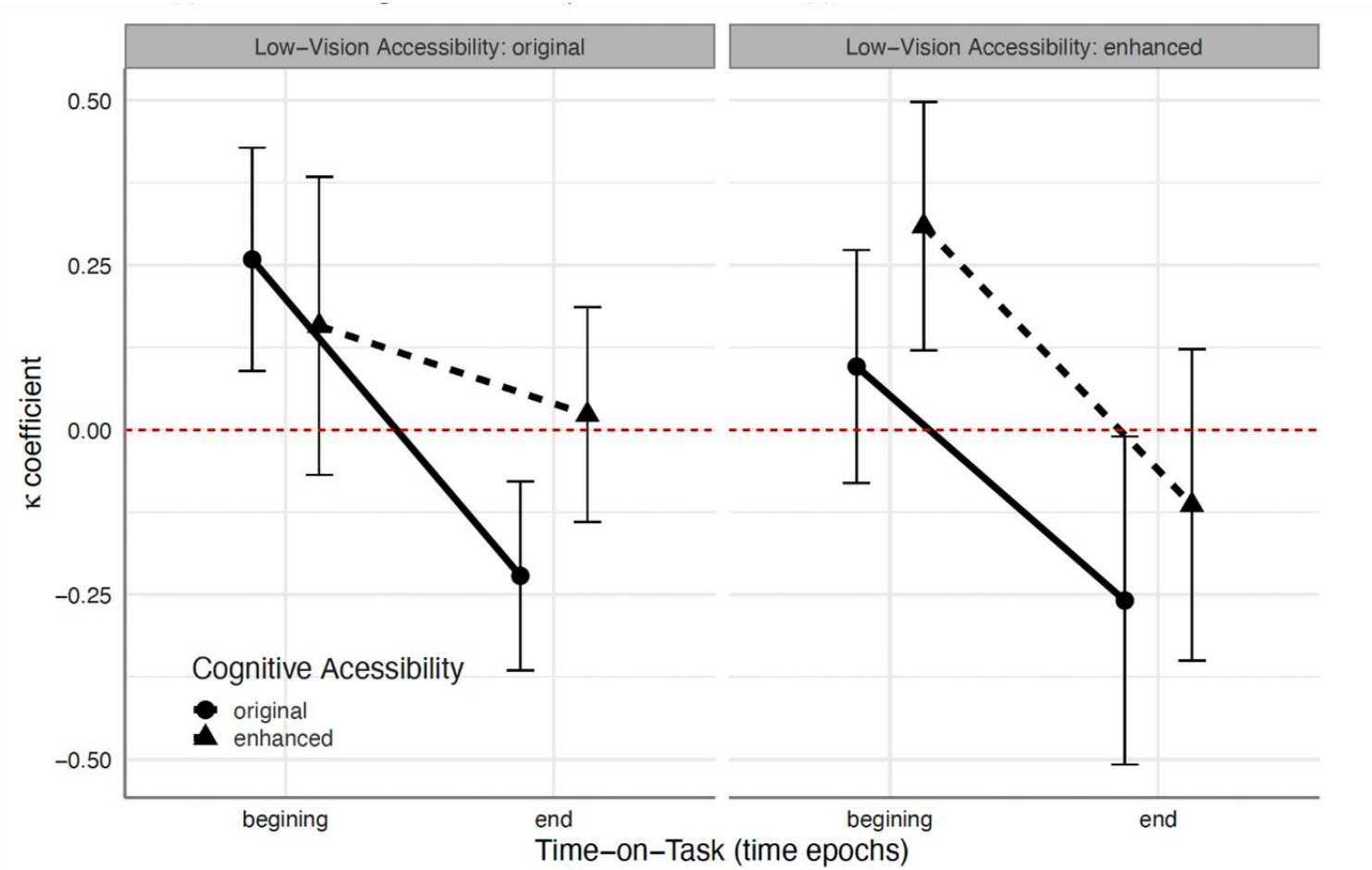
Main effect of **cognitive accessibility** enhancements showed more focal processing

↓

Focal visual processing > higher cognitive engagement

Study results
Eye metrics: Attention focus loss

H3: Differences **in visual attention dynamics between the original and enhanced websites** are due to cognitive accessibility enhancements.



Cognitive accessibility enhancement

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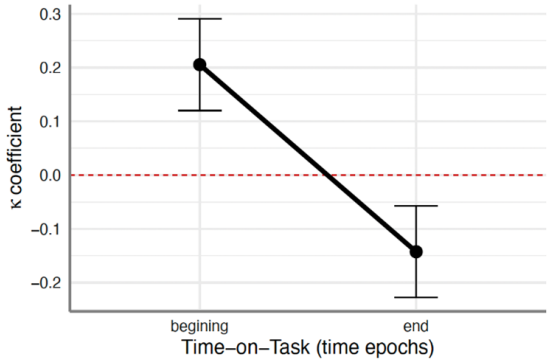
more focal attention and **less attention loss**

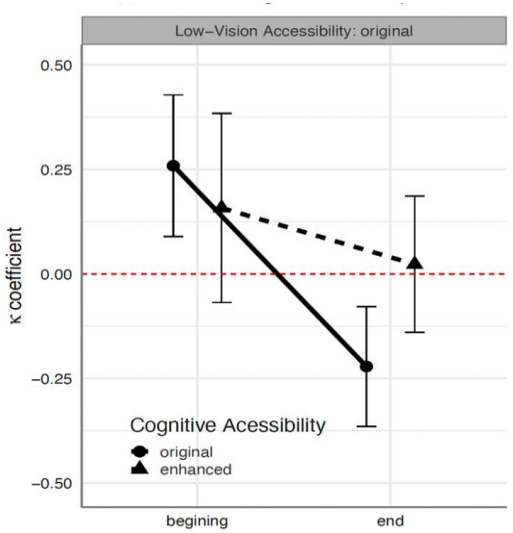
Longer focus of attention more cognitive engagement with digital content

Take home messages

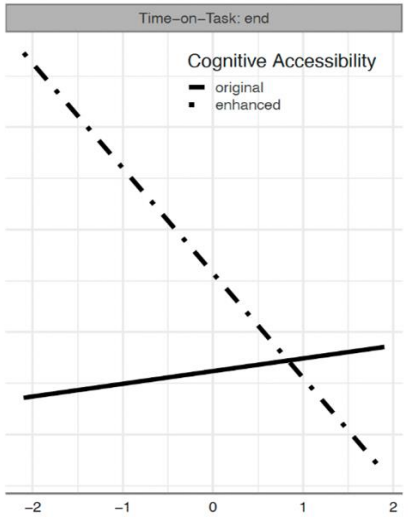
Reduction in attention focus over time



Accessibility features keep attention focused for a longer time



Cognitive accessibility enhancements are also beneficial for people with high cognitive resources



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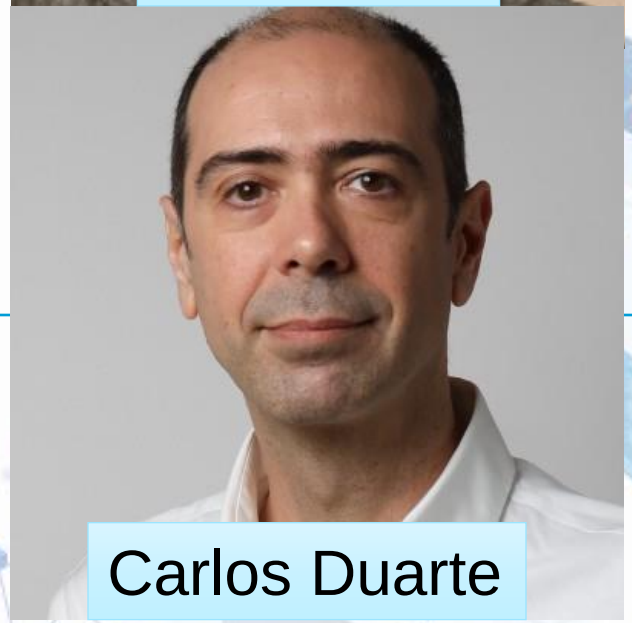
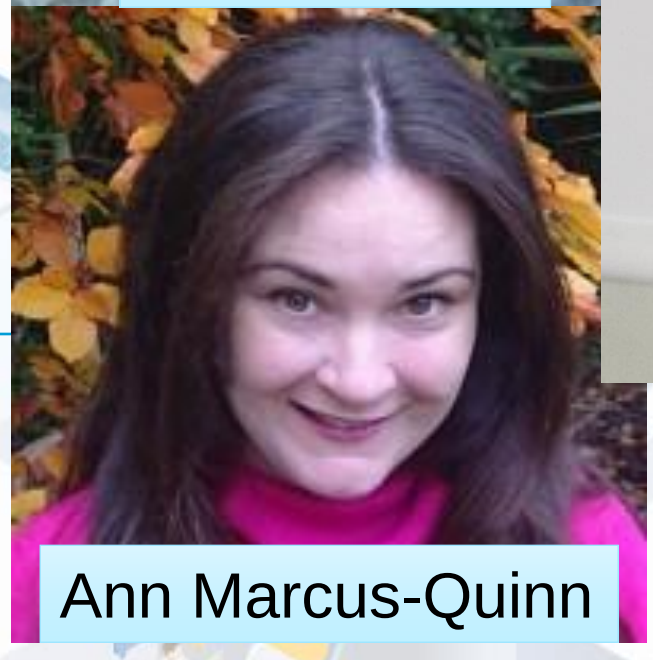
Thank you!


Merve Ekin


Izabela Krejtz


Carlos Duarte


Ann Marcus-Quinn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