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# EMICS'20: Eye Movements as an Interface to Cognitive State

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**Abstract**

Eye movement recording has been extensively used in HCI and offers the possibility to understand how information is perceived and processed by users. Hardware developments provide the ubiquitous accessibility of eye recording, allowing eye movements to enter common usage as a control modality. Recent A.I. developments provide powerful computational means to make predictions about the user. However, the connection between eye movements and cognitive state has been largely under-exploited in HCI. Despite the rich literature in psychology, a deeper understanding of its usability in practice is still required. This EMICS SIG will provide an opportunity to discuss possible application scenarios and HCI interfaces to infer users' mental state from eye movements. It will bring together researchers across disciplines with the goal of expanding shared knowledge, discussing innovative research directions and methods, fostering future collaborations around the use of eye movements as an interface to cognitive state, and providing a solid foundation for an EMICS workshop at CHI 2021.

**Author Keywords**

eye movements, cognitive states, attention, interface, interaction modality

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## Introduction

The ability to leverage eye tracking data to infer perceptual and cognitive processes during activities such as reading, driving and medical image examinations [2, 10, 16], has long been used in academic settings. However, as eye tracking systems become ubiquitous across different interfaces (e.g. desktop, mobile and head-mounted displays), new opportunities arise for applying this knowledge to human-computer interaction. This SIG will be used to explore applications that can be made possible by connecting eye movements, cognitive processing, and cognitive state [5, 8, 12, 18].

The cognitive state of a user can inform not only whether or not they stay on task, but what type of thinking (explorative, expert, creative) is currently engaged [7]. With the advent of A.I. in this field, eye movement recordings can be used to decode, guide and encourage different types of cognitive processing [1, 4, 6, 11, 21].

At the same time, the use of eye tracking in HCI has been highly promising for many years, but progress has been slow. In Jacob and Karn's review of eye tracking in HCI and usability research, they state, "We see promising research work, but we have not yet seen wide use of these approaches in practice or in the marketplace" [14] and it remains as true today as it was in 2003.

The present SIG meeting will be used as a space in which researchers from different disciplines (HCI, psychology, A.I., cognitive neuroscience) can interact and strengthen this budding field. Eye movements can, and have been, used as an input modality on mobile and head-mounted displays; for instance, for text entry or search [17]. However, the main focus of this SIG is on how eye movement patterns can be used to evaluate user intentions and task difficulty, by providing a window into the user's cognitive

processing and state. The use of eye movements to decode cognitive states could be extended to adaptive interfaces that use, for instance, eye fixations as feedback to guide attention [13, 19], affect processing [15], and provide aids for learning [20] and memory [3, 9]. The development of such tools could have some far reaching implications for our society and launch a new innovative approach to human-computer interaction.

**Relevance of the SIG meeting:** With the increasing accessibility of eye tracking devices, the growing popularity of mobile applications and head-mounted interfaces, and the development of powerful A.I. algorithms, inferring cognitive states from eye movement recordings has become feasible across many scenarios. These advancements open the possibility of integrating users' cognitive processing into the design of interactive systems. Many studies have been conducted in psychology to understand the correspondence between eye movements and cognitive processing, however this connection has not yet been fully explored or implemented in HCI. So far it remains unclear how to create meaningful interactions that make full use of the information revealed by eye movements. A fundamental challenge lies in the generalizability of eye movement patterns across different tasks, users, and contexts. With the growing interest in the inference of users' cognitive states and processing, we see an increased demand for bringing together the Cognitive Science and the HCI communities to share knowledge and explore the full potential of this intersection of research interests and its applications.

## Aims and expected outcomes

The main objective of the EMICS SIG is to bring together researchers and practitioners from academia and industry to explore the opportunities afforded by recording eye movement patterns to infer cognitive state and elevate

human-computer interactions. We will have a set of lightning talks from invited panelists kick-off an open discussion about the current cutting-edge use cases of eye movements in HCI and cognitive psychology, as well as the potential challenges and future directions in this space. Specifically, the SIG will address the following discussion points:

- Which cognitive states can be most reliably and robustly inferred from eye movements in practice?
- Which applications of eye movements as an interface to cognitive state (EMICS) have already proven successful?
- What challenges and limitations of current hardware, algorithms, etc. need to be addressed to facilitate future applications of EMICS?
- How can we best align the interests between academia and industry to solve these challenges?

After the EMICS SIG meeting at CHI, we will summarize the discussions as a report on <https://emics-2020.github.io/EMICS/>. Based on the feedback, we plan to develop it into a full-scale workshop for CHI 2021. In the future, we hope that EMICS can grow into a separate venue that can be co-located with related conferences like the ACM Symposium on Eye Tracking Research and Application (ETRA), the annual meeting of the Cognitive Science Society (CogSci) or the Vision Sciences Society (VSS).

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