The CHI'24 Workshop on the Future of Cognitive Personal Informatics

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ABSTRACT

While Human-Computer Interaction (HCI) has contributed to demonstrating that physiological measures can be used to detect cognitive changes, engineering and machine learning will bring these to application in consumer wearable technology. For HCI, many open questions remain, such as: What happens when this becomes a cognitive form of personal informatics? What goals do we have for our daily cognitive activity? How should such a complex concept be conveyed to users to be useful in their everyday lives? How can we mitigate potential ethical concerns? This is different to designing BCI interactions; we are concerned with understanding how people will live with consumer neurotechnology. This workshop will directly address the future of Cognitive Personal Informatics (CPI), by bringing together design, BCI and physiological data, ethics, and personal informatics researchers to discuss and set the research agenda in this inevitable future.

CCS CONCEPTS

• **Human-centered computing → HCI theory, concepts and models**; *Ubiquitous and mobile computing theory, concepts and paradigms.*

KEYWORDS

neurotechnology, personal informatics, digital health, well-being, work-life balance

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1 INTRODUCTION

The rapid progress in wearable neurotechnologies and activity tracking means that our cognitive activity will soon be monitored, analysed, and interpreted, similar to how wearables already quantify our physical activities [24]. The average consumer can *already* buy dedicated "brain-monitoring" devices to estimate their stress level using peripheral physiological data (i.e., tracking our breathing with the Spire Stone [22]), recognize emotional patterns (e.g., Feel [8]), recommend physiological regulatory activities such as guided breathing exercises (e.g., apple watch [1]), estimate our mental readiness for the day ahead (e.g., Oura Ring [19]), or support cognitive well-being (e.g., meditation exercises using the Muse headband [10]), concentration (e.g., Versus[23]) or work focus (e.g., Neurosity[16]).

Such tools and technologies that collect personally relevant information to support self-monitoring and self-reflection are summarised under the umbrella term of **Personal Informatics (PI)** [6]. When utilising data from and about human cognitive processing, we use the term *Cognitive* Personal Informatics (CPI). CPI aims to support individuals in acquiring, organizing, and reflecting on personal information to enhance self-awareness, self-reflection, and self-regulation of their cognitive processes. It employs sensing technology to collect and analyze data about a person's behaviour, cognitive processes, and emotions and provide individuals gain insights into their cognitive patterns and tendencies. The ultimate goal of CPI is to enable individuals to make more informed decisions, improve their well-being, and achieve their personal goals. Currently, research that seeks to classify cognitive activity is, arguably, as mature as physical activity tracking in the 2000s [13] (see Figure 1). Besides challenges of robust classification and accurate prediction of cognitive states, many open questions for the Human-Computer Interaction (HCI) community remain. While the availability of these devices creates great opportunities, it has been recognized by various stakeholders, among others the United Nations [12], that more research must be done to design affordable, diversity-supporting, healthy, sustainable, ethical, secure, and safe cognitive personal informatics devices and interactions.

1.1 The Research Gap and Open Questions

Being able to track cognitive activity does not mean we understand what it means for CPI. What is the goal of tracking cognitive activity? Who has the autonomy to determine the utilisation of our scarce cognitive resources? Is lowering stress the primary objective, and from which stakeholder's perspective? Or, is the goal to increase mental workload to the optimal extent of users' capacity? What is the ideal stress or workload pattern to target daily, and how

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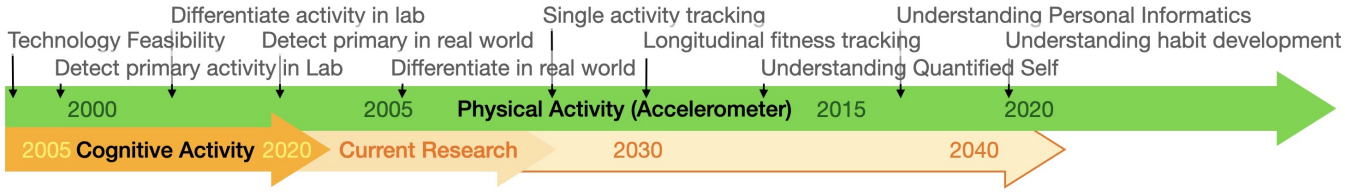

Figure 1: A proposed comparison of where cognitive activity tracking is compared to physical activity tracking, from [24].

would this apply to a society of diverse individuals and situations? How will technology appropriately communicate that we are exhibiting an unhealthy cognitive lifestyle? How will we achieve the necessary literacy in users to interpret the data they are confronted with? To what extent is CPI inclusive of or harmful to people from underrepresented groups, especially people with disabilities?

These are not questions about the classification accuracy of cognitive activity, which will move (as physical activity data did) towards being primarily a machine learning challenge. Instead, these questions address the interaction and design of devices that could significantly impact how sensitive decisions are made and how we integrate CPI into our daily activities and lives [2, 20, 25]. Hence, it is a pressing concern to understand the meaningful forms of personal data that can be revealed, to define the (un)healthy lifestyles that could result from deploying such devices [15]. Separate from state classification, we do not know what a meaningful measure of activity will be for people. Is there a cognitive unit analogous to taking a physical 'step'? If so, what is the cognitive equivalent of reaching 10,000 steps per day? How do we define good patterns of cognitive activity and responsible metrics that will have far-reaching implications for implementation in terms of how we would monitor, quantify, analyse, and interpret them? Defining such metrics for complex cognitive processes while ensuring transparency and explainability will be a core challenge. Related research from physical activity tracking has shown that designing adequate metrics in line with people's personal goals is important for creating a meaningful tracking experience [6, 18]. Additionally, the representation of the metrics in the interface and interaction has to be carefully designed to ensure a positive user experience and healthy reflection of the data [11, 17].

Moreover, access to CPI raises interesting questions about the interaction dynamics between humans and intelligent systems. What are our beliefs about the competence of technology and its ability to assess our cognitive performance? For example, research has shown that humans performed better on anagram solving when they believed that task difficulty was moderated by a system assessing their mental capacity via physiological sensing, even though this was a sham treatment [14]. How can we mitigate these effects, and how does the trust in these systems develop over time?How do the systems monitoring and handling physiological data react and provide timely feedback [7]? Should a system be designed to adapt to the physiological makeup of individuals or base its assessment on an "average" user [4]? Is it ethical to design systems with access to early and primitive information-processing systems of targeted users? It might seem sensible to design notification displays that alert drowsy drivers by exploiting physical properties that signal the approach of threat (e.g., looming intensities) [9]. But where should we stop? Is it ethical to continuously shift and adapt one's entire sense of "reality" in congruence with one's mental state and resource capacity [3, 5]?

Beginning to address all of these open HCI questions requires the involvement of a diverse set of researchers, such as experts in personal informatics, neuroergonomics, the future of work, and digital health and well-being.

1.2 The Right Time for a Workshop

A key challenge for HCI research is for individuals, society, and technology to be at the right stage to understand and answer research questions. While physiological computing has been maturing, the arrival of consumer neurotechnology creates opportunity but also a pressing demand to study how such technologies should be designed. Consumer neurotechnology was previously subject to speculation regarding its potential benefits [15, 25] and risks [15]. With advances in neurotechnology, we can now investigate its use in people's personal and professional lives. However, there is a lack of understanding regarding the benefits and goals of neurotechnology, as well as unresolved concerns related to privacy, trust, and ethics. Therefore, *now* is the time to study these open questions.

In 2022[1], we ran a 1-hour discussion forum to identify the scope of interest in this topic [24]. Around 30 participants came together from a range of communities, including activity tracking, personal informatics, ethics, well-being, visualisation, computer-mediated communication, and the future of work. To follow this, we held a workshop at MobileHCI in 2023 [21] that allowed the community to a) share and discuss more ideas for CPI from the community, b) bring together different perspectives on CPI, and c) unpack the initial ethical concerns the community may face. The outcome was a widening of the views and ideas initially identified in the SIG, which are included in the scope of this workshop. We believe now is the right time to hold a workshop that brings together the diverse communities at CHI, including device builders, personal informatics researchers, the design community, behaviour change experts, mental health studies, and those generally from a cognitive science background. Building on these two prior events, and with this diverse community at CHI, the **aims and expected outcomes** of this workshop are to

(1) disambiguate and consolidate the broad set of ideas coming from the community
(2) identify and unpack a series of Key Challenge Scenarios to help focus an agenda for the community
(3) explore the ethics and design space for these Key Challenge Scenarios

[1]CHI2022 SIG Discussion: From BCI to Cognitive Personal Informatics [24]

(4) strengthen the network between researchers and foster interdisciplinary collaboration in the community

2 THE ORGANISERS

Max L. Wilson (main contact) is an associate professor at the University of Nottingham, focused on evaluating the mental workload involved in completing work tasks and created by differences in user interfaces, using qualitative investigations and quantitative studies using fNIRS. Max has also worked on brain-controlled movies that have toured around the world using consumer brain devices. Max is also a member of the IEEE Brain NeuroEthics Committee. **For this workshop, Max will lead from the perspective of reflecting on CPI data.**

Jwan Shaban is a PhD student in the School of Computer Science at the University of Nottingham, and the thesis of her PhD directly aligns agenda of the Cognitive Personal Informatics workshop series. As an early career researcher, and reusing methods from her research, **Jwan will lead from the perspective of design for cognitive personal informatics.**

Horia A. Maior is an assistant professor in HCI within the School of Computer Science and the Horizon Digital Economy Institute at the University of Nottingham, with a focus on Mental Workload as Personal data, and the wider use of brain and physiological data in trustworthy autonomous systems, manufacturing, and other industry environments. **Horia will lead from the perspective of trust and responsible innovation.**

Christina Schneegass is an assistant professor for Cognition & Design at Delft University of Technology. She has evaluated EEG to assess language comprehension in learning systems. Her research aims to incorporate users' cognitive processes into the design and evaluation of technology to develop systems that empower users in their increasingly complex relationship with novel technologies. **Christina will lead from the perspective of user-centred design for cognition-aware systems and cognitive augmentation.**

Anna L. Cox is a professor of HCI at the UCL Interaction Centre, at University College London. Anna's research focuses on understanding the relationships between the design of information and communications technologies and behavioural outcomes, and leveraging these relationships in the design of novel interfaces and systems to support people in managing their work and well-being. **Anna will lead from the perspective of the future of work.**

3 PRE-WORKSHOP PLANS

The plan for this workshop began with the special interest group discussion held at CHI2022 [24] and was then built upon at a MobileHCI 2023 workshop [21]. From these two events, we have established a community on Slack[2] and started a Medium Blog[3]. Organising this workshop is the important next step in the long-term plan, and members of the new micro-community on Slack were invited to contribute to the organisation of this next-stage workshop. As per the previous events, a dedicated webpage will be hosted on our brain data research website[4]. We will promote the workshop on the Slack server, in research groups, and at upcoming HCI conferences. The aim will then be to generate short video promotions with key community members. These videos can then be shared by the people involved to reach a variety of communities involved in CPI. Standard CfP releases via mailing lists and social media channels will also be used to increase the reach and inclusivity of the event.

Review of Submissions. We will review submissions based on their potential to generate meaningful discussion during the workshop, with a focus on provocative perspectives and key scenarios of use. The workshop organisers will be responsible for reviewing and accepting submissions, with input from the existing Slack community if necessary. Once accepted, we will work with participants to accommodate their accessibility needs within the workshop format.

Pre-Workshop Online Engagement. To maximise the benefit of in-person interactions and enable engagement for people that cannot attend the conference in person, accepted submissions for the workshop will be asked to produce a ~5-minute research video prior to the conference. These videos will serve as the primary mode of presentation for the submitted work and will be released on a fixed schedule on a YouTube playlist between acceptance notifications and the start of the conference. The videos will be posted with provocative questions to encourage online participation (people online and expected participants) and feedback, and the resulting comments will be integrated into the workshop structure as relevant.

Pre-workshop Tasks. In the week before the workshop, we will ask participants (and members of our slack community) to watch the videos and to directly propose *Key Challenge Scenarios* via a Google Form. These scenarios are explained further below.

3.1 Accessibility and Inclusivity

We expect two accessibility aspects from accepted authors: clear subtitles on videos and annotation of PDFs for screen readers. We will approach our workshop participants to determine how we can support any other accessibility needs for the event day. We believe the pre-workshop videos and subsequent blog activities to be the key way that we include more people if they cannot attend in person.

4 WORKSHOP PLAN

The planned workshop spans a **full day** and will be built into four quarters (arranged around the natural breaks in the conference). In all parts, the aim is to encourage discussion and active creativity, rather than didactic 'presentation'. In this regard, we expect attendees to have engaged with the papers and/or videos prior to arriving, so that we can maximize discussion during the sessions and participants can make the most benefit possible from traveling to attend in person.

Expected Outcome of the Workshop. A challenge in prior discussions has been for people to be "on the same page" in terms of what the community is focused on. We have been through phases of expanding our ideas. The aim of this workshop is to consolidate them behind a series of *Key Challenge Scenarios*. The pre-arrival activities,

[2]CPI Community Slack Server
[3]Medium Blog Cognitive Personal Informatics
[4]CHI2024 CogP Workshop Website

the structure of the sessions below, and the post-workshop activities all, at least in part, aim at elaborating on these key challenge scenarios that will help set an agenda and motivate future research.

The workshop is aimed to be interactive to foster more in-depth and meaningful discussions, encourage networking and enhance community-building. Given the nature of our activities (e.g., ice-breakers, group discussions, etc.), and the relative timezone challenges, we plan to maximise the benefit of in-person discussions for people attending the conference. No special equipment beyond the normal (i.e., WiFi, projector, microphone) will be necessary.

4.1 The Sessions

(Q1) Engaging Start. To stimulate and encourage community amongst the participants, we will follow a very brief introduction to the day with interactive getting-to-know-you activities. Due to the expected diversity in participants' research backgrounds, we will start by asking people to physically move around the room, and sticker their badges, based on identifying statements (e.g. qualitative vs quantitative researcher, and research area). The ultimate aims of Q1 are a) to explicate the scope of the workshop and the expertise in the room, b) to highlight the variety of expertise, and c) to end up with mixed groups around the tables. Further, by doing so, we aim to avoid being on laptops and settling into a passive form of listening to talks. Once in mixed groups, the remainder of Q1 will focus on mapping out the *Key Challenge Scenarios* gathered in the pre-workshop activities. Participants will be asked to lay these out on their table, and establish the similarity and uniqueness of what has been proposed. If we have a large number of participants, we will do this in parallel on several tables, to compare the different outcomes before the first break.

Break 1 Task. We will ask participants to vote on their top three key challenge scenarios, using sticker dots.

(Q2) Elaborating on Key Challenge Scenarios. Based on the voting during the break, we will identify the top N scenarios (as a ratio to the number of natural tables in the room), to elaborate on during the second session. While we consider the voting, the organisers will also curate the final selection to make sure a range of user types and different types of cognitive activity are captured in the final selection. During Q2, we will ask participants to develop a series of artefacts for these key challenge scenarios: personas, user stories, and scenarios. The session will end with the sharing of these elaborations to the room.

Discussion Lunch. As people head of to lunch, we will ask them to discuss two key topics over lunch: a) interesting aspects of the elaborated key scenarios, b) aspects we may be missing, and c) initial ethical considerations that come to mind.

(Q3) Designing for Key Scenarios. To avoid a post-lunch slump, this session will first bring the ideas back to the room from lunch. We will aim to pin additional thoughts and ethics questions as additional artefacts to the key challenges. The main aim of Q3 will then be to engage in design and prototyping activities, which specifically focus on imagining what CPI apps would look like that feed current, recent, and historic data for that user story and for the concerns of the associated personas.

Break 2 Task. Just prior to the break, we will announce our plans for an edited book series, and invite participants to discuss ideas for chapters with us over the break.

(Q4) Reporting Key Challenge Scenarios, and Future Plans. The afternoon session will focus on writing up the Key Challenge Senarios into shared google docs, as draft blog posts that will go on the CPI medium blog. We expect this to rather smoothly transition between people wanting to work a little longer on the designs, and perhaps those feeling good about explaining the key scenarios in writing. These key challenge scenario blog posts will be released weekly in the month after the conference.

During these write-up activities, the organisers will move from table to table to discuss proposed future plans, including the edited book chapters, and ideas such as an extended dagstuhl event focusing on CPI.

4.2 Flexibility and Adapting

As experienced organisers[5], we will leave scope to adapt the plan, both as the workshop approaches and as the day progresses. If the outcomes of the morning and lunch highlight specific discussions that should be continued rather than interrupted by the schedule, we will extend Q2 after lunch, moving Q3 to fill the afternoon. Session Q4 can indeed carry on beyond the day of the workshop, but we hope to achieve as much as possible on the day.

4.3 Asynchronous Opportunities to Engage

We want to enable involvement, in some form, for people that cannot attend the conference location in person. Asynchronous engagement will be initially enabled by the videos that accepted authors will be asked to produce. This allows a wider audience to access the material both before the workshop, and indeed for years after the conference has taken place. These videos will invite people to join the slack community, where a dedicated channel will allow people to submit comments and thoughts, and other forms of contribution to stimulate discussion at the workshop. The same slack server will enable us to keep people involved in outcomes of the workshop and in the build up to the edited book (see below).

5 POST-WORKSHOP PLANS

Workshop Contributions and Outcomes. With enough contributions, we will publish research papers and position papers the workshop proceedings on CEUR-WS.org. The Key Challenge Scenarios produced in the workshop will also be posted on our Medium Blog, as one of they key post-workshop activities. These posts will also invite questions, commentary, and discussion through our existing slack community. We hope this will continue the asynchronous involvement of people unable to attend the conference. Participants that submit to the workshop, but become unable to travel, will be invited to write a blog post, to go along with their pre-workshop video as an author.

Edited Book on CPI. We have been approached by Springer with the view of creating an edited book on Cognitive Personal Informatics, for release in 2025. Contributors to the workshop, and from the

[5]Wilson, for example, has previously run two successful workshop series: EuroHCIR and RepliCHI

prior events, will be invited to help shape the CPI research agenda by contributing chapters that expand on their perspective in this emerging and diverse research area. The key challenge scenarios would form part of the introduction and conclusion chapters in the book. We believe an edited book would better enable a developing community in describing their positions and research visions in relation to research outputs, than a journal special issue that would require more mature research outputs for peer review.

Community Development. We plan to continue the development of this community by organising follow-up community workshops, potentially including a Dagstuhl proposal and further workshops at SIGCHI conferences (e.g., IUI, UbiComp). Additionally, involved authors will provide mentorship to early-career researchers via the CPI Community Slack Server and future events.

6 CALL FOR PARTICIPANTS

This workshop explores the future of cognitive personal informatics. Looking beyond classifying cognitive states, the goal of this workshop is to examine *why* people will track their cognitive activity and *how* they will benefit from doing so. Especially in a world where wearable technology is beginning to estimate stress, and consumer neurotechnology is available at low cost.

We invite 1) Research summaries (4-6 pages), 2) Position papers (e.g. essay, design fiction) (4-6 pages), or 3) Attendee abstracts (1 page) that describe your research perspective. Submissions will be reviewed for how they will provoke discussion and contribute to understanding key use cases. Submissions should be aligned (but not limited) to the following topics:

- Studies of how people manage their cognitive activity frequently and or longitudinally.
- Research into how cognitive activity is conceptualised and understood by people.
- Comparisons that differentiate between different types of cognitive activity
- Research into communities that could benefit from or be harmed by (mis)use of CPI.
- Research into the designs that enable reflection on CPI.
- Discussions of ethical, legal, and regulatory concerns.

We consider work on physiologically-driven interaction and cognitive state classification out of scope. Submissions should be in single-column ACM format, submitted to HotCRP via [our website]. The workshop will be in-person only, but with ways to get involved asynchronously. Research summaries and perspectives papers will be published via CEUR-WS, and authors will be asked to record a 5-minute video to be shared prior to the workshop.

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