

Human-Computer Counter-Choreographies:
a new choreographic approach and web tools to
improve user awareness and empowerment towards
online tracking algorithms

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Abstract

Human-Computer Counter-Choreographies (HCCC) is a practice-based research project that critiques and counteracts the impact of data-tracking technologies on people and society. These algorithms are ubiquitous in daily life and often operate seamlessly on people’s digital devices without their awareness.

HCCC investigates the following question: how can a choreographic approach to human-computer interaction and computational arts counteract the effects of data extraction in daily life, by increasing awareness of online tracking, and inspiring user behavioural change?

To address this inquiry, *HCCC* employs a methodology that combines elements of artistic research, critical design, choreography, and embodied sense-making. This approach is applied to how knowledge is communicated and experienced through the design of artworks, activities, and empirical studies.

HCCC comprises several components: a live-coding performance piece, a workshop series, a browser extension, and a digital artwork. A total of more than ninety people participated in these activities, providing insight into the research’s iterative development and analysis. Data from each activity were collected and analysed using a mixed qualitative and quantitative approach. The findings of *HCCC* demonstrate that its embodied and choreographic approach improved participants’ awareness of the prevalence, intrusiveness and invisibility of data tracking.

HCCC makes two significant contributions to human-computer interaction (HCI): first, it introduces a new approach that bridges choreography with online tracking; second, it provides empirical insights on how choreography can be used to engage people in critical examinations of online tracking in their daily lives.

The research findings from *HCCC*’s artworks, designed activities, and empirical studies can inform practices in HCI that use embodiment to foster algorithmic awareness and criticality among users.

Human-Computer Counter-Choreographies advances approaches that counter extractivist technologies by centring bodies in growing awareness and critical reflection of online tracking. It encourages new ways of drawing attention to online tracking through an embodied choreographic approach. The concept of counter-choreographies prompts people to critically reflect on online tracking and supports behavioural change in relation to such algorithms. In doing so, it empowers users to engage with data-extractive technologies more critically, paving the way for more equitable data futures.

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A profound acknowledgement to the live-coding community, which has been a source of inspiration for over a decade; to the DuckDuckGo team, for taking the time to support my project; and finally to the London Tango community, for making me dance and sweat.

I dedicate this thesis to my mother, Gisela Chicau — I wish you were here. To Pedro (dad), who has always been by my side throughout my career and in life. To Pedro (brother) for sharing solace and laughter through difficult times. To my partner, Ulysses, for endless proofreading and for being the first to believe in the power of counter-choreographies. Last but not least, to our daughter Eulália, a new beginning of love and hope.

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List of abbreviations

AI	Artificial Intelligence
CMPs	Consent Management Platforms
FLOSS	Free/Libre Open Source Software
GDPR	General Data Protection Regulation
GenAI	Generative AI
HCCC	Human-Computer Counter-Choreographies
HCI	Human-Computer Interaction
ML	Machine Learning
PETs	Privacy-enabling Technologies
UbiComp	Ubiquitous Computing

Disclaimer

In the writing on this thesis, I have used language writing assistant software tools for grammar correction (not for generating text), some of which are AI-powered, such as Grammarly, Writefull and a self-hosted instance of Llama.

0.1 Preamble

0.1.1 Counter-

‘As a noun, counter means a table, where accounts are made or persons meet, thus an object, which is in opposition.

A counter is also a device that counts.

As an adverb, it describes a way that opposes something.

It operates as a prefix to something to oppose or to react to.’

(Miyazaki and Eylül İşcen, 2021)

0.1.2 -Choreography

‘Choreograph (v.): to arrange relations between bodies in time and space. [...]

Choreography (n.): order observed..., exchange of forces; a process that has an observable or observed embodied order.

Choreograph (v.): to recognize such an order.

Choreography (v.): act of interfering with or negotiating such an order.’

(Klien et al., 2008, p. 9)

0.1.3 Counter-Choreographies

Continue reading.

Chapter 1

Introduction

Human-Computer Counter-Choreographies (HCCC) is a practice-based research that uses embodiment and choreography to reveal and critique data-tracking algorithms commonly found in everyday web environments.

In the words of Bucher, algorithms can be described as a ‘step-by-step instruction’ fed to a computer. This definition draws similarities to choreography, which is also a sequence of movement instructions (as demonstrated in Figure 1.1). Bucher continues by describing algorithms as ‘a form of programmed logic’, but also as ‘an automated filtering mechanism, what platforms use to guarantee the best user experience possible, an appetiser to make you crave for more of the same...’ (Bucher, 2018, p. 19).

Algorithmic systems are often made opaque by design, and users are unaware of how much of their data is being collected (Pold, 2019) and for what purposes. Algorithmic systems have been reported to inflict harm and perpetuate inequality in various ways (Klumbyte et al., 2020). Among these systems are online tracking algorithms, which are present in most web services (Kretschmer et al., 2021). Surveillance capitalism (Zuboff, 2015) has been the driving force of online tracking technologies for decades. The advertising sector is at the forefront of collecting extensive datasets on online user activities. They perform predictions and feed advertising technologies that serve targeted content and ads to influence user behaviour (Williams, 2018). Online tracking typically involves recording users’ online interactions, including website visits,

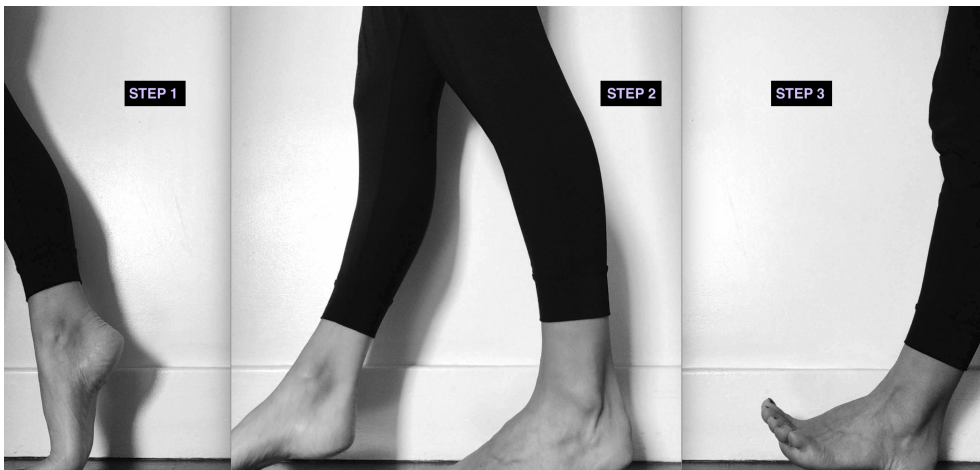


Figure 1.1: Example of a three-step choreography by Joana Chicau (2025).

page views, and clicks on links (Peacock, 2014). Companies track and analyse large amounts of this data to profile users, recognise patterns and relations, and predict their future behaviour (Christl and Spiekermann, 2016).

Both data tracking algorithms and choreography share a common interest: patterns. In the words of the choreographer and writer Susan Leigh Foster, choreography is ‘the act of arranging patterns of movement’ (Foster, 2009, p. 98). Choreography opens a space to reflect on movement patterns that can be seen as habitual or conditioned, or it can be an opportunity to explore new movements. In *Patterns of Life: A Very Short History of Schematic Bodies*, Chamayou draws parallels between movement capture in the arts, through dance notations, and in behavioural science. The author highlights the shared quest for traceability of gestures and movements in various fields, including police, military, and marketing, which continuously track daily movements of individuals (Chamayou, 2014). Choreographic practices can both reinforce existing forms of control over people’s movements and serve as a means to critically investigate movement, thus offering a complex and nuanced perspective on this issue (Egert, 2022; Lepecki, 2015). Moreover, choreography and movement-based practices enable individuals to prioritise their embodied experiences.

In this context, *HCCC* investigates how choreographic and embodied approaches can raise awareness of online tracking algorithms. It undertakes an analysis of the regulatory powers of choreography (from dance to everyday life) to identifying potential avenues for user behavioural change towards data extractivist technologies. In the next chapter, I will dive into the references that influence my work. Before that, I will briefly contextualise and situate my practice and introduce the research questions and contributions from this thesis.

1.1 Author’s Background

I am a designer and researcher with a background in dance. I hold an undergraduate degree in Graphic Design (2014) and a post-graduate degree in Media Design (2016). In 2010, completed the Advanced II degree of Cecchetti Classical Ballet. I have worked with choreographers from Gulbenkian and the Companhia Nacional de Bailado, such as Benvindo Fonseca. More recently, I have taken dance classes at Dansateliers, Movement Research, Companhia Instável, Siobhan Davies, ImPulsTanz, among others. Currently, most of my dance time is dedicated to Tango. My passion for dance and choreography shapes my work and research within HCI, which aims to widen the way digital technologies are presented and made accessible to the public.

My work incorporates dance, choreographic, and embodied techniques to provide a critical understanding of technology and its impact on people and society through the creation of digital artworks (Chicau and Bell, 2022) and workshops (Samani et al., 2024; Soon and Cox, 2021). I have also been an active member of the live-coding community for a decade (Champlin et al., 2023; Hoogland et al., 2023), and I have created several live-coding performances



Figure 1.2: Performance *Webpage in Three Acts* at Galeria Zé dos Bois, Lisboa (2018). Credit: Ana Caria and Leonor Fonseca, FBAUL

(Blackwell et al., 2022b; Chicau, 2017; Chicau and Bell, 2018a; Verano Merino and Sáenz, 2023) and open-source tools (Chicau and Bell, 2018b; Chicau and Reus, 2023). I am inspired by web and net art and am interested in the web browser as a medium for artistic expression and critique.

I am an associate lecturer (SFHEA) in the master's programme Internet Equalities at the Creative Computing Institute at the University of the Arts London and a visiting lecturer at The Lucerne School of Art and Design (HSLU), Switzerland. My work in embodied methods extends to teaching practice and pedagogy.

My PhD topic originated from my interest in how surveillance and data tracking operate on the Web and how my body-centred choreographic background could respond to them.

1.1.1 Situated Context

I am a white female, able-bodied, and non-English native speaker.

In accordance with Haraway's concept of situated knowledge (Haraway, 1988), I acknowledge that my dance education has endowed me with a deep familiarity with movement, a comfort level that may not be shared by people without prior experience in somatic practices or dance. This understanding informed the design of the activities, which incorporate physical movement (as described in Chapters 5, 6, and 7), favouring simple movements and gestures with which participants could easily engage. Centering bodies in my work also has a political dimension: it supports a critique of technological development that often overlooks and homogenises embodied experiences (Spiel, 2021; Tsaknaki et al., 2025).

Moreover, I acknowledge the limited scope of the analysis of the issues raised in this document, which mainly covers my Eurocentric context and some

knowledge of the South American context. Although aware of this limitation, my aim is to provide references representative of diverse perspectives.

1.2 Research Ethics Approval

The studies that are part of this PhD research received formal ethical oversight and approval from the UAL Creative Computing Institute Research Ethics Subcommittee (CRESC). Data collected and used as part of all research has been archived in anonymised form and no personally identifiable information will be accessible to any researchers outside the core research team without further consent. Data have been securely stored on servers associated with UAL in the UK, which are GDPR compliant and to which only our data manager and researchers have access. All participants were informed about the nature of the studies and provided consent for their contributions to be used in my PhD research. Participants were given my contact details and the option to withdraw at any time, at which point all references to them and their data will be removed as far as is possible.

1.3 Research Questions

This thesis explores embodied and choreographic approaches to promote algorithmic awareness, transparency, and understanding. The main question provides a lens through which to view a practice-based research process, guided by empirical experiments and reflective practice.

- RQ1: What is a choreographic approach to countering data extraction in the context of human-computer interaction and computational arts?

Two questions were used to further guide the project's research activities toward more concrete results, with a focus on online tracking algorithms.

- RQ2: How can this choreographic approach increase awareness of and reflection on online tracking in people's lives?
- RQ3: How can this new approach inspire forms of raising awareness that lead to user behavioural change?

In line with the questions above, the research first focused on designing activities that revealed the prevalence of online tracking and allowed participants to critically reflect on it. Further, the research expanded on these activities that lead to user behavioural change towards data extractivist technologies.

1.4 Research Contributions

Many concrete research contributions are built upon this unusual intersection of interests and fields of practice.

Firstly, an overarching embodied and choreographic approach that involves users in critically reflecting and raising awareness of online tracking.

Secondly, a demonstration of aspects of practice which help illustrate and explain my approach, which includes the design of:

- a new version of the DuckDuckGo browser extension;
- a performance piece;
- a workshop series;
- an artwork displaying a collection of 12 scores;

Following a practice-based research approach (detailed in Chapter 3), the design and production of these creative artefacts are the basis for the contribution to knowledge.

And third, evidence from empirical studies:

- audience response to three performances;
- participants' response to one workshop (preceded by two pilot workshops);
- participants' response to a longitudinal study using the collection of scores;

I also demonstrate how these contributions can lead to user behavioural change towards data extractivist technologies.

Research Activities Undertaken

Performances

- April 2023: International Conference for Live Coding (ICLC), Utrecht, The Netherlands.
- June 2023: Critical Making & Social Justice (HASTAC), Pratt Institute NYC, US.
- July 2024: Conference on Computation, Communication, Aesthetics & X (xCoAx), Fabbrica Treviso, Italy.

Workshops

- April 2023: Control Shift Festival, Bristol, UK.
- May 2023: Space 2, Leeds, UK.
- October 2024: Creative Computing Institute UAL, UK.

Final Exhibition

- February-April 2025: Everyday Algorithms, at the NewBridge Gallery in Newcastle, UK.

1.5 Associated Publications

The detailed sections of the work in this thesis have been published in international academic conferences and journals as follows:

- Chapter 5 is adapted from a paper published at: Chicau, J. et al. 2025. ‘Human-Computer Counter-Choreographies: Raising Awareness of Data Tracking through Live Coding’. In CHI Conference on Human Factors in Computing Systems (CHI ’25), April 26–May 01, 2025, Yokohama, Japan. ACM, New York, NY, USA, 14 pages. Available at: <https://doi.org/10.1145/3706598.3713432>
- Chapter 6 is adapted from a paper published at: Chicau, J. et al. (2025) ‘Designing Counter-Choreographies: Embodied Choreographic Approaches for Critical Examination of Online Tracking’, in Proceedings of the 2025 Conference on Creativity and Cognition. C&C ’25: Creativity and Cognition, Virtual United Kingdom: ACM, pp. 872–885. Available at: <https://doi.org/10.1145/3698061.3726928>
- Chapter 8 is adapted from a paper, currently in the second round of revisions, for publication in the En/Countering Tracking: Resisting spatiotemporal media operations in computational culture. A special issue of Computational Culture, a Journal of Software Studies.

In all papers, I was the first author and the main writer; my supervisors contributed to editing and improving the paper in response to reviewers’ feedback. In the second paper, workshop participants were invited to proofread or make suggestions to clarify or enrich the content of this text.

An adaptation of the programming scripts, originally part of the work described in Chapter 4 was published in a short essay in the book: Strauss, C. F. et al. 2025. ‘Slow Technology Reader: A Tool for Shaping Divergent Futures’. Amsterdam: Valiz. Available at: <https://valiz.nl/en/publications/slow-technology-reader>

Other published work related to the thesis, but not included in it:

- Chicau, J., Popova, K. and Fiebrink, R. 2024. ‘From Individual Discomfort to Collective Solidarity: Choreographic Exploration of Extractivist Technology’, in Proceedings of the Eighteenth International Conference on Tangible, Embedded, and Embodied Interaction. TEI ’24: Eighteenth International Conference on Tangible, Embedded, and Embodied Interaction, Cork Ireland: ACM, pp. 1–3. Available at: <https://doi.org/10.1145/3623509.3634739>
- Popova, K. et al. 2024. ‘Discomfort in the making of technologies: (re-)choreographing agency’, in 22nd European Conference on Computer-Supported Cooperative Work. The International Venue on Practice-

centered Computing on the Design of Cooperation Technologies. Available at: https://doi.org/DOI:10.48340/ecscw2024_ws03

- Samani, H. et al. 2024. ‘Creative Robotics Theatre: Designing Creative Interactions with Tangible and Embodied Interfaces’, in Designing Interactive Systems Conference. DIS ’24: Designing Interactive Systems Conference, IT University of Copenhagen Denmark: ACM, pp. 389–391. Available at: <https://doi.org/10.1145/3656156.3658387>

Ancillary-related activities and presentations, for dissemination of work:

- 2023: Web-based Artwork and Essay: ‘re-coding everyday technology’ VOL. 1. Available at: <https://re-coding.technology/choreographing-you>
- 2024: Podcast Episode 2, Technology and Bodies, Control Shift Podcast. Available at: <https://control-shift.io/blog/episode-2>
- 2024: Podcast episode ‘Dancing with Joana Chicau’, Data Fix Podcast, hosted by Mél Hogan. Available at: <https://shows.acast.com/the-data-fix/episodes/dancing-with-joana-chicau>
- 2024: Talk at MESH Festival, discourse programme for ‘Tooling the Future’ panel on AI and Digital Justice Tools, Basel, Switzerland.
- 2025: Talk at FOSDEM (Free and Open Source Software Developers’ European Meeting) at the Open Research Track, Brussels, Belgium.
- 2025: Presentation at the Research Spotlight Competition at the London Hopper Colloquium, UCL UK.
- 2025: Featured in a report in Neural magazine edition 76 ‘What is real?’. Available at: <https://neural.it/issues/neural-76-what-is-real>
- 2025: Keynote at the Web Audio Conference (WAC) at IRCAM, Paris.

Chapter 2

Contextual Review

2.1 Introduction

This chapter focuses on two main areas of study and their intersection: (1) embodiment and choreography, with (2) data extractivist technologies. The references draw primarily from the fields of human-computer interaction (HCI) and computational arts. To contextualise this research, this chapter is divided into four sections.

First, I introduce choreographic practices that reflect upon daily life and society with reference to choreographers who have deeply inspired my work. I provide examples of choreographic practices of notation through movement scores. Then I refer to the historical rise of embodiment perspectives within HCI and how technological approaches supported the democratisation of choreographic practices.

Secondly, I present approaches to performance that expose live computational processes ('live coding') and integrate them with embodiment and choreography. I provide examples of work that merge systems of notation within computation with other forms of expression, namely choreography, to explore the discursive power of language. I then lead into a subset of live-coding practices that use the web browser as an artistic medium.

Third, algorithms commonly found in users' daily lives are introduced, with a focus on online tracking algorithms and user data. I discuss current concerns and responses to the opaqueness of algorithms within surveillance capitalism (Zuboff, 2015). I refer to tracking techniques such as cookies, browser fingerprinting and issues surrounding deceptive and harmful user experiences.

Finally, I gather references that challenge data extractivist technologies (Evgeny, 2017; Mejias and Couldry, 2024) and advocate algorithmic transparency, data justice, and solidarity. I expand on contributions from HCI and computational arts that make use of embodiment and choreography as a vehicle for algorithmic awareness and criticism.

Throughout these sections, I describe how my work builds on, complements, and extends existing research in these fields.

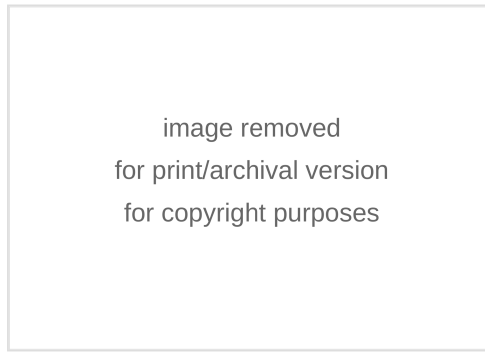


Figure 2.1: Boal, A. (2008) Participants in the Theatre of the Oppressed workshop presented at Riverside Church in New York City. Available at: https://commons.wikimedia.org/wiki/File:Theatre_of_the_Oppressed1.jpg (Accessed: 05 June 2025)

2.2 Everyday Movement

As introduced in Section 1, choreography can be defined as the arrangement of movement sequences or patterns (Foster, 2009). Klien et al. expand on this idea: ‘Patterns are not rigid, they are fluid constellations, appearing and disappearing, crystallizing and dissolving [...] To enquire into the world of changing patterns and the forces at play is to enquire into the choreography of life, examining what makes us dance and why’ (Klien et al., 2008, p. 11). The authors highlight the potential of patterns to reflect on movement that extends from dance to life more broadly: ‘we, ourselves, are part of the larger choreographies and our acts are acts upon them’ (Klien et al., 2008, p. 1). Klien et al. see choreography as an exploration of a wide ‘grammar of patterns’ of movement interactions, and relationships they form. Choreographic practices thus engage with the world of patterns and patterns in the world.

American choreographer Yvonne Rainer took inspiration from the observation of individual pedestrians and crowds on the streets of New York City. She transposed the movement patterns observed from the streets into the theatre and opened new possibilities for performing the self and interactions with others (Wood, 2007). Rainer was part of a larger dance community that took daily gestures, postures, and movements – such as walking or dressing – and reconfigured them.

Another source of inspiration is the work of the Brazilian physical theatre practitioner Augusto Boal, initiator of the Theatre of the Oppressed (Teatro do Oprimido) in the 1980s. Boal understood theatre as a rehearsal for everyday life, not an end in itself but the beginning of social transformation (Boal, 2019). Boal developed games to be used in his theatre training (see Fig. 2.1) that supported the de-alienation of bodies and minds, aiming at disrupting the repetitiveness of daily tasks. These games (Boal, 2022) guide people towards identifying movements they perform mechanically that have become habits, and then introduce small alterations. They draw our attention to muscles that are rarely used to activate bodies’ sensitivity and explore its potential.

While Boal moved from theatre to reality, Rainer moved in the opposite direction and saw the world as a stage. In their work, they both question ‘why’

we move in certain ways and not others, to re-evaluate everyday routine and movement patterns. Another useful reference is Andrew Hewitt’s proposal of the notion of Social Choreography (Hewitt, 2005), which emphasises how social order is aesthetically created, embedded, and practised. Thus, choreographic practices can question movement patterns and how to assert our freedom of movement, power and agency in society (Egert, 2022; Lepecki, 2015).

The references above transcend the study of choreography within dance performance, gazing towards everyday movement and how social order shapes contemporary society. They inspire my choreographic and movement-led approach that pays special attention to day-to-day gestures to reflect on agency or its lack within algorithmic systems. In *HCCC*, I invite people to enact tracking by performing physical tasks, such as clapping or asking them to focus on the gestures they perform on their digital devices, such as their phones.

2.2.1 Movement Scores

Etymologically, choreography stands for writing movement. The writing artefact produced by choreography is called a choreographic score. Choreography has evolved through a rich history of techniques, constituting a complex creative process akin to other compositional methods, where diverse formal procedures are explored to produce distinctive artistic creations (Alaoui et al., 2014; Birringer, 2013; Loke et al., 2015). Contemporarily, choreography extends to a multimedia and interdisciplinary activity that often integrates spoken language, texts, images, light, sound, objects, and computational processes (Jürgens et al., 2021). This aspect of choreography as movement documentation ensures its reproducibility (Mestre, 2017). Choreographic scores are not neutral; they carry specific worldviews on how bodies should move. For instance, they can be used to homogenise movement by dictating a particular set of movement patterns deemed appropriate for a given dance genre. In contrast, scores can also create moments of interpretation and improvisation, providing a critical lens through which to reflect on movement performance and embodiment (Folkerts, 2016).

A multiplicity of scores and systems of notation have been devised for dance across genres and periods. One of the most prominent ones is Laban Movement Analysis (LMA), developed by Rudolf Laban, a comprehensive language to describe, represent, express, and perform movements (Laban, 1963). LMA historically emerged from dance, but has been applied to various other contexts, including human-computer interaction, such as in prototyping systems (Silang Maranan et al., 2014).

Although acknowledging the utility of LMA as a commonly used choreographic method, my research is more significantly informed by the post-modern dance movement of the 1960s. This period is defined by its rejection of choreographic conventions and a fertile context for dancers and choreographers to experiment with and develop alternative dance notation systems. These were often inspired by observing and appropriating what could be perceived as mundane movement forms: ‘Everyday movements became dance, and dance became everyday’ (Rosenthal et al., 2010, p. 11). An example of following

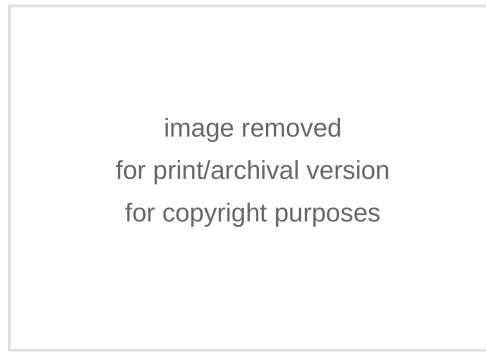


Figure 2.2: McGregor, W. (2013) *Choreographic Thinking Tools, Mind and Movement*. Available at: <https://magpie-studio.com/work/mind-and-movement> (Accessed: 05 June 2025)

this type of practice is the aforementioned Yvonne Rainer, who has written her choreographies in the form of floor plans accompanied by image sequences and text descriptions (Wood, 2007).

A more recent example is the work by William Forsythe in collaboration with the association edna/Boris Chamatz and Siemens Arts Program, who devised 15 choreographic instructions for the public to encounter during their daily routines. These instructions were disseminated at the annual Paris event Nuit Blanche, via electronic noticeboards, such as bus stop screens announcing arrival times, and on the radio. Participants could follow these instructions publicly or privately, alone, or with others. Instructional cards were also printed in Braille and distributed in public spaces, schools, libraries, among others (Spier, 2011).

Another is the work *Choreographic Thinking Tools, Mind and Movement* by Wayne McGregor (see Fig. 2.2), a publication that fosters the creation of innovative and original dance scores by cultivating imaginative skills. It includes 12 guiding principles in the form of vocabularies: ‘assign/choose’, ‘exemplify/ make it specific’, ‘superimpose/ layer’, ‘change over time’, ‘scale/ change the size’, ‘change perspective/ change the point of view’, ‘relocate/ move’, ‘substitute/ replace’, ‘recontextualise/ change the scene’, ‘personalise/ make It your own’, ‘add deconstruct/ take it apart’ (McGregor et al., 2013, p. 6). These principles can be applied individually or in combination to explore more extensive variations of movement patterns.

These choreographic approaches have influenced how I compose choreographic prompts (see Sections 5.2.4; 6.2.3) and scores (see Chapter 7) that instruct people to enact and reflect on online tracking within *HCCC*. For these textual prompts and scores, I created a movement vocabulary that combines daily gestures performed by people both offline (such as standing up) and online (such as scrolling). Participants were also invited to propose new scores by making simple modifications. For example, they could choose to ‘add’, ‘remove’ or ‘substitute’ parts of the original ones.

2.2.2 Embodiment in HCI

Embodiment is not a new concept; it has been fundamental to specific strands of philosophy since the nineteenth century (Dourish, 2001). For example, the school of philosophical thought called phenomenology is centred on ‘how we perceive, experience, and act in the world around us’ (Dourish, 2001, p. 21). Phenomenology focuses on reconstructing the link between experience and action (Dourish, 2001), arguing against the Cartesian dualism that separates the mind and body. The idea that bodies are divided into thinking and doing parts is rooted in the philosophical legacy of the Enlightenment. This notion persists in some domains and has been reinforced with the advent of digital computation in the second half of the twentieth century (Penny, 2019).

In *Where the Action Is*, Dourish builds on phenomenology to define embodiment as the ‘way in which we encounter physical and social reality in the everyday world’ (Dourish, 2001, p. 100). In HCI, theories of embodiment can be divided into two main threads: embodied cognition and embodied interaction.

Embodied cognition refers to approaches that reconsider the traditional Cartesian understanding of cognition. As Xambó et al. exemplify, ‘the role of the environment related to the situated body and mind, or the role of physical experience related to abstract concepts’ (Xambó et al., 2014, p. 2).

Embodied interaction ‘is concerned with the phenomenological aspects of HCI’ (Xambó et al., 2014, p. 2), more specifically, ‘the creation, manipulation, and sharing of meaning through engaged interaction with the artifacts’ (Dourish, 2001, p. 126). Dourish identifies two main strands in the field of embodied interaction, namely: Tangible Computing a “perspective that blends computation and physical design to extend interaction ‘beyond the desktop’ ” (Dourish, 2001, p. 55) and Social Computing which refers to ‘the application of sociological understanding to the design of interactive systems’ (Dourish, 2001, p. 55).

For more than two decades, computer science has been incorporating understanding of the social world into interactive systems (Dourish, 2001). Relevant to these two strands are the notions of situatedness and context: the actions we perform are tied to a particular situation and shaped by their context and surroundings (Suchman, 1987). The setting in which action arises is part of a broader ‘social, cultural, and historical’ context (Dourish, 2001, p. 96). Hence, the embodiment is not solely understood as in physical manifestation but also as ‘grounded in and emerging out of everyday, mundane experience’ (Dourish, 2001, p. 125).

An example of an early work that privileged embodiment in HCI is Seymour Papert’s Logo programming language, created in the 1960s. The logo was connected to a robotic pen, called a Turtle (see Fig. 2.3), which the children could programme to create drawings. Papert compared dancing to the technomathematical operability of the Logo environment and expanded the comparison to Brazilian samba schools, highlighting their culture of solidarity and flat hierarchies as a model to emulate (Papert, 1980).

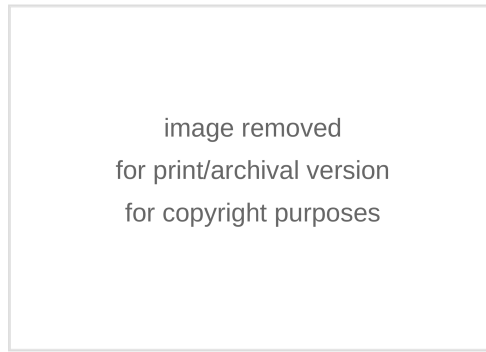


Figure 2.3: P, Seymour. Turtle Robot (n.d.). Available at: https://commons.wikimedia.org/wiki/File:Seymour_Papert.jpg (Accessed: 05 June 2025)

Created as an extension of Logo, Starlogo by Resnick, Kopfer and Wendel at MIT Media Lab in 2001, continued the legacy of ‘experiencing, testing, and rehearsing agent-based models in a bodily and situated way, through role-playing and group exercises in order to better understand them’ (Miyazaki, 2023, p. 83). They presented and tested group exercises called StarPeople in various conferences: ‘StarLogo and StarPeople form a hybrid brain-body-media dispositif and ensemble. Here, the primary goal was immersion in complexity through interactive movement games that are also, in the broadest sense, dances’ (Miyazaki, 2023, p. 83).

Soma means ‘body’ and the American philosopher Thomas Hanna defined the term ‘somatic’ as the area of study focused on the soma, specifically examining bodies as perceived first-hand (Johnson, 1995). Only in the last 20 years has there been an increased interest in ‘somatic sensibility’ (Loke and Schiphorst, 2018) within design research and practice in HCI. This interest in bodily felt experiences and tacit knowledge has grown beyond the field and has expanded to a wider contemporary discourse (Loke and Schiphorst, 2018). The latter has manifested in two recent ‘turns’ referred to as the aesthetic and the somatic turn. The first is characterised by a growing attention to materiality and aesthetics, and the second is characterised by an experiential first-person methodology (Tsaknaki et al., 2019). An example of this is Soma design (Hook, 2018), which intersects somaesthetic concepts and theories by Richard Shusterman (Shusterman, 2014) with HCI research.

A more recent line of work integrating dance and movement to improve algorithmic literacy includes projects such as Body.Scratch (Arthur and Anh Tu, 2023), a tool designed for children and adolescents that uses the visual programming language Scratch with choreographed movements to engage learners in an embodied and cooperative process to grasp concepts in Computer Science. Data Theatre (Bhargava et al., 2022) is an entry point for growing data literacy by engaging participants in the emotional embodied performance of data stories. Bodygramming (Mikkonen, 2019) is another approach that uses embodiment to develop an understanding of basic programming concepts in physical computing. These projects integrate embodiment and movement-based practices as part of the learning processes in Computer Science, aiming to democratise coding and increase algorithmic literacy.

Although embodiment has increased in popularity within HCI, bodies are often portrayed in a narrow sense. Katta Spiel analysed 45 papers published at the ACM International Conference on Tangible, Embedded, and Embodied Interaction (TEI) in the 14 years since its inception. Spiel identified the need to diversify and expand the notion of bodies, which are often presented as normative and idealised. This notion of a ‘sanitised ideal’ (Spiel, 2021, p. 9) within embodied computing is built on unrealistic scenarios and contrary to the reality of ‘the messiness of human bodies and their lives, the non-ideal circumstances’ (Spiel, 2021, p. 9). Most recently, the more-than-human shift in HCI, rooted in non-human-centric epistemologies and ontologies, challenges definitions of ‘the body’ (Homewood et al., 2021; Tsaknaki et al., 2021). The more-than-human encompasses not only the non-human but also elements that extend beyond, yet remain connected to what we consider human (Manning, 2012).

HCCC integrates aspects of body politics (Tsaknaki et al., 2025), embodied cognition, and embodied interaction with an emphasis on the situatedness of everyday experience (Dourish, 2001; Suchman, 1987). It also uses the first-person methodology (Chapter 3) characteristic of the somatic turn in HCI.

In this thesis, I use plural ‘bodies’ consciously and purposefully, following Spiel’s provocations for embodied interaction to account for the complexity and diversity of embodied experiences beyond static and singular norms. The single ‘body’ implicitly invokes an image of ‘an abstract, adult, healthy, isolated, nondescript, typically male, typically white body’ (Spiel, 2021, p. 9), and often does not account for the bodies of children, elderly, disabled, trans people, BIPOC.

2.2.3 Democratizing Choreography in HCI

Existing research in HCI has considered technological approaches to supporting, transmitting, and democratising choreographic practices, as discussed in previous literature reviews on dance in HCI (Alaoui et al., 2014; Jürgens et al., 2021; Zhou et al., 2021). In particular, the field of Movement Computing has focused on the aesthetics, technologies, and languages used to augment movement-based creativity and computer-assisted choreography. However, this focus has not always been accompanied by a broader critical examination of the cultural, social, and political effects of technologised movement (Sutil, 2017). Work in this field has contributed to developing platforms and systems that make visible information on the practitioners’ dance composition, conceptual framework, and, at times, socio-political views. Examples include Motion Bank (Forsythe and Scott, 2011) and Synchronous Object (Palazzi et al., 2009) two online platforms that document the arrangement of movement and choreographic structures of a set of dance pieces. Although the content of these two systems differs, they both aim to enrich performers’ and audiences’ comprehension of choreographic work. These two works have made dance data and choreographic processes visible with the incorporation of text annotations. Sarma (‘Sarma’, 2002) is an online database that hosts documentation of workshops, labs, research projects, and research publications in

the performing arts. This database has been a useful resource for *HCCC* in showcasing multiple approaches to publishing scores involving audience participation. The *Double Skin/Double Mind* (DS/DM) installation (Alaoui et al., 2015) followed by the ‘pre-choreographic’ system by Emio Greco and Pieter C. Scholten (EG|PC) formalise terms, categories, metaphors, types and modifiers to train dancers to embody specific movement qualities (Kleida, 2020). This work is part of a longer lineage of practice developing interactive systems for the documentation of the dance vocabulary of EG|PC (deLahunta, 2007). Recently, choreographer Wayne McGregor collaborated with Google Arts and Culture to create an artificial intelligence (AI-driven) tool that generates choreography based on a repertoire of video footage from McGregor’s archives. The idea of the tool is to transmit the repertoire by allowing dancers to generate their own version of it (McGregor, 2019).

These works highlight the importance of creating tools to share and transmit movement practices. They also illustrate how dance practices have contributed to HCI and computing by bringing to the foreground the centrality of meaning-making with the moving bodies (Loke and Schiphorst, 2018). My work builds on this literature and proposes the use of dance, choreography, and embodiment to reflect on computational processes.

The approaches mentioned so far cover the embodied, contextual, and situated nature of interacting with algorithmic artefacts. There is less of a focus on problematising the algorithmic models in place and the political context within which those same technologies are embedded. The following sections will address those aspects.

2.3 Performing with Algorithms

Live coding, also referred to as on-the-fly or just-in-time performance (Blackwell et al., 2022a) is a practice in which computer code is written live in front of an audience, making visible the algorithmic processes the performers undertake. A live-coding performance is typically set up with projections that allow the audience to follow the algorithmic compositions being created. It incorporates various forms of artistic practices and expressions, including visual and musical composition, choreography, and poetry.

Various contributions from HCI have explored live coding to better understand real-time processes and performance work (Purcell et al., 2014; Swift et al., 2014) or its potential in pedagogy (Selvaraj et al., 2021). Although most examples are centred on live coding for music composition, recent approaches embrace interdisciplinary work, for example, by integrating dance and choreography, as detailed below.

2.3.1 Embodiment in Live Coding

In 2023, the International Live Coding Conference (ILCC) hosted an evening programme dedicated to the theme ‘Choreographic Coding’. Moreover, two out of the three keynote speakers, Kate Sicchio and Marije Balmaan,

presented their embodiment-focused live-coding practices. In Baalman’s theatrical piece *The Machine is Learning*, she trained a machine to detect simple gestures that she performed, yet it repeatedly failed to do so accurately (Baalman, 2021). In her piece *Untitled Algorithmic Dance* (Sicchio, 2016), Sicchio fed images of bodies in motion to a t-distributed stochastic neighbour embedding algorithm (t-SNE), producing new choreographic scores which were interpreted by a dancer during live performance. In *Codes for a Dance* (Sicchio and McLean, 2023), the authors interact with two robots on stage through a series of gestures that influence the soundscape. These works explore the tensions between machinic interpretation and human agency, often resulting in broken expectations. At times, the algorithm misinterprets the dancer and vice versa, which invites the performers to embrace improvisation and adapt their response to the algorithms. More recently, her project *Together//Apart*, uses a human-robot coding platform that combine live-coded spatial patterns and algorithmic gesture patterns to create a performance score (Sicchio, Kaney et al., 2025).

These projects combine embodiment and live coding with a myriad of techniques. Another example is the live-coding environment *CO/DA* that facilitates real-time manipulation of motion data from one or more dancers and can be programmed to generate audio feedback (Françoise et al., 2022). The GravField project is an interdisciplinary system that combines live coding, embodiment, and improvisation in a co-located mixed-reality environment (Hu et al., 2024). In addition, the research project *MosAIck* (Wilson et al., 2023) connects live-coding practices with dance mediated by e-textile sensors.

This thesis draws from this history of novel approaches to live coding that, like *HCCC*, integrate choreography and embodiment as integral aspects of the work. The specificity of *HCCC* is to add choreography to live coding to engage the audience in embodying online tracking algorithms (see Chapter 5).

2.3.2 Performativity of Code

Depending on the discipline, notation practices can take different forms, from ‘colloquial use for various note-making practices, to other forms of score, script, recipe, or diagrammatic map, to the development of a formalised notation system with its own clearly defined inner logic’ (Blackwell et al., 2022a, p. 127). The same authors add that the concept of notation becomes blurrier within interdisciplinary practices. This blurriness is explored in *HCCC* by combining algorithms as a ‘step-by-step instruction’ (Bucher, 2018, p. 19) given to computers with dance scores as sets of instructions for movement sequences (Foster, 2009) performed by human bodies.

Live coding entails the modification of written symbols, such as a part of a given programming language or a notation system. These systems of notation are seen as a process: ‘the art is not in the written notation itself but in the activity of notation, as performance over time. The programming is part of the program’ (Blackwell et al., 2022a, p. 142). This notation process is embodied and situated, in the words of the writer Emma Cocker, the coder “oscillates between sense-making through the discontinuous, abstract notational form of

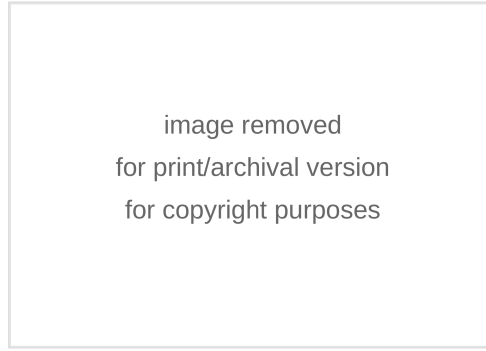


Figure 2.4: Kurylonek, K. (2016) *Hacking Choreography* by Kate Sicchio. Available at: <https://www.sicchio.com/work-1/hacking-choreography> (Accessed: 5 June 2025)

code and the ‘continuous’ – even sensuous – experience of coding as a lived experience” (Cocker, 2016, p. 106). She adds that the process of live-coding ‘becomes ingrained in mind and muscle, activated at the fingertips, live and emergent to the situation’ (Cocker, 2016, p. 110).

Within live coding, notation serves various purposes, such as facilitating the learning of programming languages and software. It can also be customised to serve the needs of the coder when writing and altering code, and ultimately, it is a form of expression in and of itself. The fact that the notation is written live opens another layer of possibilities for how programming can be used as a form of communication with audiences. This transient character of live notation is ‘closer to speech than text’ (Blackwell et al., 2022a, p. 142). This notion of code as speech is further articulated in the book *Speaking Code* (Cox and McLean, 2013).

Code as speech can be seen in connection with ‘its ability to act and perform as in speech act theory’ (Arns, 2005, p. 2). Speech Act theory by J. L. Austin (Austin and Urmson, 2009) defines performative speech acts as sentences that simultaneously describe while doing the thing that is being described. Thus, saying and doing are intertwined. This performative quality ‘is not to be understood as a purely technical performativity, for example, it does not only happen in the context of a closed technical system but affects the realm of the aesthetic, political and social’ (Arns, 2005, p. 7).

Building on this idea, *HCCC* seeks to leverage the performative capacity of code by combining it with the embodied language of choreography. This process not only combines both the practices of computer programming and choreography but also mixes the language and logic characteristic of each practice. This follows esoteric programming which adds syntax and meaning to the standard syntax of functional or procedural programming (Temkin, 2022a). This form of programming can support the interpretation and contextualisation of the code for those who encounter it. Esoteric programming has been manifested in various artistic practices, pedagogy, and activism.

One example is the work of the above-mentioned Kate Sicchio, who investigates the intersection of code and choreography through both choreographic devices and programming languages (Sicchio, 2023; Sicchio, Kaney et al., 2025; Sicchio and McLean, 2023; Sicchio, McLean and Iannini, 2025). In *Hacking*

Choreography (Sicchio, 2012), she creates a coding language based on Java that is hacked during a performance (see Fig. 2.4). Artist-researcher Winnie Soon, in their work *Vocable Code* (Soon, 2019), merges computer code and human languages to explore the linguistic tensions associated with writing and reading within the realm of (non)binary poetry and computer programming. By bridging esoteric programming with live-coding practices, these works embrace ‘the misdirection of technological know-how’ (Blackwell et al., 2022a, p. 231) and question how new vocabularies may guide us through questioning the seemingly fixed algorithmic structures of our computational surroundings. These works inspired *HCCC* to use a hybrid language that combines code and choreography as a critical means to explore new aesthetic possibilities and expressions outside the standards and conventions established within computational systems.

2.3.3 Revealing Algorithmic Processes: ‘Show us your screens’

The principle of making the code visible, by displaying the performer’s screen, is a common characteristic of live-coding performances. One of the lines of the TOPLAP manifesto, first drafted in 2004, says: ‘Give us access to the performer’s mind, to the whole human instrument. Obscurantism is dangerous. Show us your screens.’ (Ward et al., 2004, p. 247). There are different motivations for live-coding performers to want to share their software and tools with audiences. Inherent in this gesture is the quest for transparency that gives ‘technical credibility (even virtuosity)’ (Blackwell et al., 2022a, p. 4). For others, the didactic quality of exposing the coding process is the driving force.

The emphasis on transparency in live coding is also rooted in the Free Libre Open-Source Software (FLOSS) movement, which prioritises knowledge sharing and resource accessibility (Wouter, 2010). Although not everyone shares the same ethical and political views on this matter, the practice of showing and sharing prevails.

However, the quest for transparency in live coding, which manifests itself in the showing of live coder screens and code, is never that of full transparency. Transparency is always partial and selective, as live-coding languages have many levels of operational abstraction that are not entirely visible to the audience (Chicau and Reus, 2023). There is a choice of when and how to reveal parts of the thinking process, often to optimise code performance: ‘live coders have always used their own libraries and convenience classes to make live coding faster and less of an inventing-the-wheel-in-front-of-a-live-audience process’ (Blackwell et al., 2022a, p. 243). Transparency is not a simple binary of visible and hidden, but a complex and subjective process. This gradient between transparency and opacity extends to the larger algorithmic ecosystem (Section 2.4.2) and a growing concern towards the accelerating processes of data extraction (see Section 2.4).

As introduced in Section 4.1, and further discussed in Chapter 5, *HCCC* is highly influenced by live-coding practices and ethos. Due to its focus on online tracking and web interfaces, the next section highlights practices that

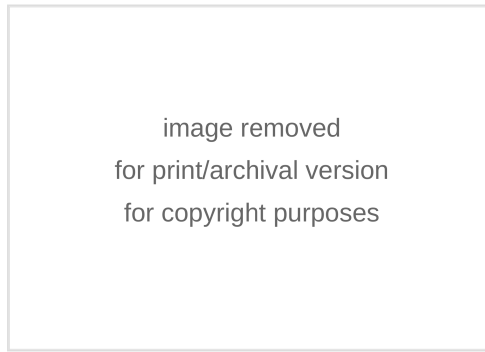


Figure 2.5: Example of a browser-based live-coding tool, LocoMotion. Available at: <https://estuary.mcmaster.ca> (Accessed: 30 May 2025)

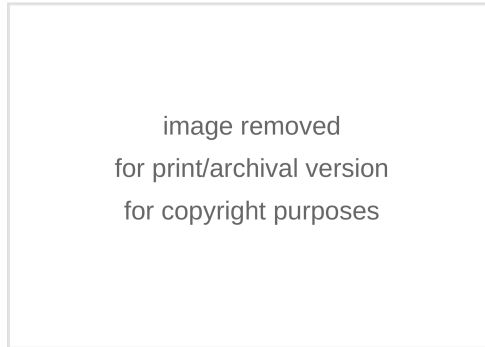


Figure 2.6: Carmichael, R. (2016) Details of the publication *Care to Dance?*. Available at: <https://fleeimmediately.com/02-danceandcode/dancefloor.html> (Accessed: 05 June 2025)

use the browser as an artistic medium.

2.3.4 The Browser as a Stage

As browsers have expanded their graphic and audio capabilities, a growing number of browser-based live-coding environments have emerged (Roberts and Pachon-Puentes, 2019). The development of these environments started as early as 2012 (Ogborn et al., 2017), examples include *Gibber* (Roberts, 2012), *LiveCode Lab* (John and Della Casa, 2014), *Hydra Synth* (Jack, 2017), *P5.JS Live* (Davis, 2019) (which integrates various creative coding libraries), the web-based platform for 3D models and motion capture data *LocoMotion* (Ogborn et al., 2021) (Fig. 2.5), the node-based platform *Nodysseus* (Popple, 2021), *Cascade* (Bastide, 2021) (which maps HTML and CSS attributes to sound), *Strudel* (Roos and McLean, 2022) (the web version of *TidalCycles*), *Sema* (Bernardo et al., 2019) which integrates machine learning, and others. Finally, the project *Live Coding YouTube* (Lee et al., 2018) uses a custom interface that allows streaming media to be sourced and remixed from YouTube.

In the broader computational arts scene, various web extensions have been created in response to concerns about online tracking and algorithmic surveillance. For example, the piece *Listening Back* (Guffond, 2019) employs an add-on for the Chrome and Firefox browsers that maps Internet cookies to different sounds, creating a melody while browsing. While *HCCC* shares similarities with *Listening Back* in the use of data trackers' sonification, it differs

from it by expanding on other forms of tracking and incorporating embodied interactions and active audience participation.

Other work includes *GoogleTeller* (Hubert, 2022), a tool that makes audible each packet or tracker request sent to a Google service. The *Safebook* plug-in (Grosser, 2019) removes all Facebook content, leaving the interface as an empty grid of white, grey, and blue circles and squares. Finally, *Demetricator* (Grosser, 2017) removes all metrics from the Twitter feed. These last two interventions question the quantifying nature of these platforms.

In the online publication *Flee Immediately* (Carmichael, 2016b), Carmichael created a series of instructions using the iconography of hand gestures to guide the user, step by step, on how to navigate the browser. In her editorial text *Care to Dance?* (Carmichael, 2016a) (see Fig. 2.6), she repurposes the Laban dance notation to define a user choreography that involves actions such as ‘scrolling’, ‘zooming’ and ‘breathing’. In doing so, she draws attention to the design of the user experience, the interface environment, and the specificities of the browser.

HCCC expands on this previous work by exploring browser-based live-coding to critique online tracking (see Chapter 5). Although online tracking is pervasive, bringing these algorithms to the centre stage to reflect and interrogate them is far from the daily experience of a user. The format of a browser-based live-coding performance in *HCCC* opens possibilities to witness in-action algorithms that are most often obfuscated and made invisible to users.

2.4 Everyday Algorithms

This thesis focuses on data extractivism (Evgeny, 2017), specifically data captured from user devices and online platforms accessed in daily life. These platforms are largely controlled by a small number of corporations—often referred to as GAFAM (Google, Amazon, Facebook, Apple, and Microsoft) and BAT (Baidu, Alibaba, and Tencent) (Bonini and Treré, 2024).

2.4.1 Online Tracking

Each day, we click, scroll, and share our location or voice commands with digital artifacts. These actions generate data collected by the websites we visit, apps, or digital devices we use. Most of the systems with which we interact perform some form of online tracking (Kretschmer et al., 2021). As Bonini and Treré emphasise, ‘our bodies and actions are continuously calculated and transformed into flows of data that feed the platforms’ algorithms. We are constantly subjected to a process of stripping and extracting biometric, biographical, and demographic data that in the era of big data has been called datafication’ (Bonini and Treré, 2024, p. 3). These large amounts of data provide valuable context for companies to track, analyse, and profile users based on their online behaviour and predict their future behaviour through targeted advertising (Christl and Spiekermann, 2016). From URL to URL, online tracking algorithms fuel the advertising technology ecosystem and, more

broadly, web technologies in general (Williams, 2018).

The advertising sector is at the forefront of collecting extensive datasets on users' online activities to perform predictions and feed advertising technologies that serve targeted content and ads to influence user behaviours (Williams, 2018). Data profiling is a core component of online advertising, enabling platforms to build detailed user profiles by tracking online behaviour. These profiles are used by major platforms – including Facebook, Google and YouTube – to identify patterns and deliver targeted advertising, driving a significant portion of their revenue (Dent, 2025). Based on patterns in user data – including shopping habits, interests, and location – algorithms can predict which individuals are likely to be receptive to specific advertisements (Büchi et al., 2020; Dent, 2025). Although it can be difficult to trace exactly what data triggers specific ads or content to be shown: ‘was it my clicking behavior, my age and gender, pages that I have liked, the cookies set by the online design store where I bought the gift for my mom, my friends’ clicking behavior, the friends of my friend, everything or nothing of the above?’ (Bucher, 2018, p. 14). As Bucher mentions, it is also difficult to draw a line between the data captured from our individual online behaviour and those of others within our network of relations.

Various countries are regulating the use of user data, algorithms, and computational systems, for example, by applying the European General Data Protection Regulation (GDPR), a law in effect in the European Union (EU) since 2018. According to GDPR, personal data is defined as data through which a person can be directly or indirectly identified (Art. 4: GDPR Definitions, n.d.). These data can be demographic data, such as age or geographic location, or metrics associated with user engagement, such as time spent on a webpage. In addition, GDPR defines sensitive data as a special category of personal data that includes racial or ethnic origin, political opinions, religious or philosophical beliefs; trade-union membership; genetic data, biometric data processed solely to identify a human being; health-related data; and data concerning a person’s sex life or sexual orientation (Art. 9 GDPR: Processing of special categories of personal data, n.d.).

GDPR established new parameters for data rights, privacy policies, and data processing transparency and introduced binding sanctions that can be imposed on those who do not comply (Kretschmer et al., 2021). However, a study measuring the impact of GDPR on the Web concluded that although overall transparency in data collection and processing has increased, there is no evidence that online tracking has decreased (Kretschmer et al., 2021). The reasons for the latter are many. These include the violation of GDPR requirements (Trevisan et al., 2019) or the use of deceptive design and dark patterns, which are manipulative and deceptive functionalities employed in digital systems against the best interests of the user, even where they do not fall foul of GDPR (Bongard-Blanchy et al., 2021; C. M. Gray et al., 2018).

Cookies, Fingerprinting and Other Tracking Techniques

Various, ever-evolving techniques enable tracking user data online and they usually operate seamlessly without users even realising. These techniques enable website owners, advertisers and data brokers to gather comprehensive information on users’ online behaviour and preferences, frequently without users’ explicit consent (Papadogiannakis et al., 2021).

An example of a tracking technique is the use of cookies, small pieces of data in plain text format with no executable code that are created by a web server when a user visits a website (Dimova et al., 2022). Another example is fingerprinting, a tracking technique that collects the settings of the user’s web browsers to uniquely identify them, which is commonly achieved by embedding JavaScript code in the website (Kretschmer et al., 2021). Cookies and fingerprinting are two of the most common online tracking techniques used by ad services (Kretschmer et al., 2021). Another common technique is link tracking, which collects data about a user’s browsing history and other information via personal identifiers embedded in those same links. Images and other embedded content, such as videos, posts, and comments from social media companies, can also be used for tracking across websites.

New techniques are always emerging; Alphabet (Google parent company) is developing a Privacy Sandbox with proposals, namely Topics, FLEDGE and Attribution Reporting APIs for custom marketing and advertising tools and techniques without the use of cross-site third-party tracking (Merewood, 2022).

Deceptive and Harmful User Experiences

Deceptive design and ‘dark patterns’ refer to manipulative and coercive design practices, used to implement deceptive functionalities in digital systems that are not in the user’s best interest (Bongard-Blanchy et al., 2021; C. M. Gray et al., 2018). Examples include: ‘Obstruction: making a process more difficult than it needs to be, with the intent of dissuading certain action(s)’ and ‘Forced Action: requiring the user to perform a certain action to access (or continue to access) certain functionality’ (C. M. Gray et al., 2018, p. 5). Some of these strategies can be seen in the design of cookie banners or pop-ups.

An online business which proliferated with the advent of GDPR was Consent Management Platforms (CMPs), a popular one being onetrust.com. CMPs have been introduced to manage GDPR requirements in online environments, with the intent to ‘ease advertisers’ legal liability’ (Fassl et al., 2021, p. 2). However, in a study, Nouwens et al. found that the design of the most prevalent CMPs affected people’s choice of consent due to deceptive design patterns, with only 11.8% following the minimal requirements set by GDPR (Nouwens et al., 2020).

To highlight limitations around transparency, Pothong et al. problematise Article 5(1)(a) of the GDPR, which views transparency as a tool for individuals to exercise their right to control the visibility of information related to themselves. In the authors’ words: ‘such autonomy over information

pertaining to individuals depends on individuals’ information and technology literacy, rather than information about the data being processed.’ (Pothong et al., 2021, p. 2). (See further problematisation of transparency in the next Section 2.4.2). Studies have shown that most users have little understanding of the complexity of web tracking and often do not connect targeted online advertising with the concept of tracking (Fassl et al., 2021). Fassl et al. raise awareness of the fact that the latter puts into question consent: ‘[users] do not seem to fully understand that personalized ads rely on their tracked online behavior, how widespread these trackers are, which information these trackers can access, and what types of personal information advertisers can derive from their behavior. Users can, by definition, not give their informed consent to data practices they do not understand’ (Fassl et al., 2021, p. 5).

Persuasion defies consent, one example is the cookie consent notifications which are commonly designed to increase and exploit compliance: ‘website owners simply treat the request for consent as one more persuasive interaction, and deploy the same methods of measurement and experimentation they use to optimize their advertising-oriented design in order to manufacture users’ consent’ (Williams, 2018, p. 116).

Finally, Kretschmer et al. call attention to the exhaustion of users, even though users, in general, do not agree with cookies, they ‘are often unsatisfied with consent notices or insecure about the effect they have. As a result, they commonly just ignore cookie banners (around 70% of the time) if possible’ (Kretschmer et al., 2021, p. 8). Various authors have focused on the issue of user disengagement and emphasised the importance of conserving a user’s limited decision-making capacity to truly impactful and non-trivial choices (Fassl et al., 2021).

As discussed so far, users are overwhelmingly exposed to online tracking algorithms on a daily basis. Policy efforts to safeguard user privacy are challenged by corporate tactics and the fast-paced development of technologies. In the next section, different perspectives on algorithmic transparency are presented and problematised.

2.4.2 Transparency Becomes Performative

As mentioned by Star and Ruhleder, transparency has often held a dual meaning: it was akin to ease of use or user-friendliness within technical contexts, contrarily, in political contexts, it encompassed notions of openness and accountable procedures (Star and Ruhleder, 1996). This technical understanding is prevalent in the field of Ubiquitous Computing (UbiComp), coined by Mark Weiser, which emphasises the seamlessness of the user experience (Inman and Ribes, 2019). For Weiser, an experience should be seamless to the point that the tool itself is rendered invisible to the user, in his words: ‘to make a computer so embedded, so fitting, so natural, that we use it without even thinking about it’ (Weiser, 1994, p. 1). Later, the same author advocated for seamfulness, calling for ‘well-designed configurability and strategic revelation of complexity, error, or backgrounded tasks’ (Inman and Ribes, 2019, p. 2).

To describe the disappearance of the interface in ‘the environment and

everyday cultural practices’, Andersen and Pold introduce the concept of ‘metainterface’ (C. U. Andersen and Pold, 2018, p. 10). They describe it as a phenomenon that evades perception becoming ‘global (everywhere) and generalized (in everything)’ (C. U. Andersen and Pold, 2018, p. 10). The notion of ‘metainterface’ highlights the difficulty of grasping it due to its ubiquitous, networked, and dispersed quality. With its omnipresence, users’ behaviours continually feed into the intelligent system of the interface, forming a cybernetic feedback loop (C. U. Andersen and Pold, 2018). In *New ways of Hiding*, Pold refers to two different aspects of the concealing of the interface. The first being minimalist hiding, which concerns ‘the hiding of the datafication, monitoring and profiling going on in cloud computing infrastructures behind its immediate, minimalist user-interface’ (Pold, 2019, p. 73). The second concerns environmental hiding, which includes ‘hiding its mode of control as smart for example’ (Pold, 2019, p. 73).

In computer science, a ‘hidden’ system — characterised by complete opacity — is often referred to as a black box. This concept ‘asserts the components of a system need only to be understood in terms of their interfaces— their inputs and outputs’ (Penny, 2019, p. 60). Discussions around how to open the sealed box of algorithmic systems or the difficulty of grasping all at once, as in the concept of the ‘metainterface’, have been growing with the popularisation of AI systems.

A more desirable scenario is the opposite of opacity – fully transparent algorithmic systems. However, the quest for transparency has been driven by the assumption that ‘observation produces insights which create the knowledge required to govern and hold systems accountable’ (Ananny and Crawford, 2018, p. 2). The view of ‘autonomy-through-openness assumes that information is easily discernible and legible; that audiences are competent, involved, and able to comprehend the information made visible’ (Christensen and Cheney, 2015). Various authors have pointed out how opening the ‘black-box’ is not enough (Ananny and Crawford, 2018; Hong, 2018); a clear, see-through mechanism does not imply legibility and does not necessarily empower different parties to hold systems accountable.

In this sense, transparency becomes performative: it casts systems as knowable, and, by articulating their inner workings, it produces understanding (Ananny and Crawford, 2018). Rader et al. describe the different functions that transparency is thought to perform: ‘awareness, correctness, interpretability, and accountability’ (Rader et al., 2018, p. 2). Thus, transparency is not just about see-through technologies, but it is a ‘system of observing and knowing that promises a form of control’ (Ananny and Crawford, 2018, p. 3).

Transparency can be used as a way to obscure information that is, in fact, useful in cases where there is information overload or ‘data dumps’. Ananny and Crawford describe different typologies of pseudo-transparency that have emerged in algorithmic systems, both at the platform and software levels. Examples include “fuzzy transparency (offering ‘information that does not reveal how institutions actually behave in practice’ or transparency as event (the ‘inputs, outputs, or outcomes’ that define the ‘objects of transparency’)

instead of as process or procedures” (Ananny and Crawford, 2018, p. 4). These exemplify how transparency is not considered as a whole and how it is often, tactically, only partially adopted.

The ongoing tension between disclosure and concealment, visibility and invisibility, transparency and opacity, as well as seamfulness and seamlessness, continues to persist. Some call for a compromise: ‘presumably we cannot reveal every detail of the entire system all the time, and so we will have to be selective and, to some extent, reductive with regard to the features and processes we open up’ (Chalmers, 2004, p. 4). This idea speaks to the point of selective transparency (Chicau and Reus, 2023) referred to in the 2.3.3 section.

The work referenced so far has critiqued the industry development and policy lapses in addressing algorithmic transparency, awareness, and understanding. Although efforts to improve algorithmic literacy should not be solely the responsibility of the user, it is crucial that users make informed decisions about their daily use of technologies (Oeldorf-Hirsch and Neubaum, 2025). There is a history of definitions on what constitutes algorithmic literacy (Oeldorf-Hirsch and Neubaum, 2025), a recent one describes it as ‘the capacity and opportunity to be aware of both the presence and impact of algorithmically-driven systems on self- or collaboratively-identified goals, and the capacity and opportunity to crystalize this understanding into a strategic use of these systems to accomplish said goals’ (DeVito, 2021, p. 3).

HCCC explores what emerges from exposure to the embodied and choreographic approach (described in Chapter 3.2.3) and how it supports people in becoming more aware of data tracking in their lives. *HCCC* did not measure how people increase their understanding of specific algorithmic functionalities within online tracking. Instead, the research first focused on designing activities that revealed the prevalence of online tracking and allowed participants to critically reflect on it. As a second step, the research explored ways to inspire user behavioural changes towards data-extractive technologies. This follows the argument of Rader et al., who point out that ‘awareness on its own is necessary but not sufficient to bring about the ultimate goal of transparency mechanisms: enabling users to take action to change the system in some way’ (Rader et al., 2018, p. 9).

The next section presents an overview of projects and initiatives dedicated to similar efforts of raising awareness of data extractivist technologies.

2.5 Raising Awareness of Data Extractivism

Data extractivism is tied to a range of negative consequences, including the infliction of harm, systemic inequalities, and injustices (Chagnon et al., 2021). It disproportionately affects vulnerable and marginalised communities. This speaks to how data-driven systems reproduce various aspects of the matrix of domination (Hill Collins, 1990). The matrix of domination is a term developed by the Black feminist scholar Patricia Hill Collins to refer to race, class, and gender as interlocking systems of oppression. This model provides a lens to systemic forms of oppression that affect people’s lives and should be kept in

mind when making similar analyses. In this context, it is crucial to emphasise the effects of surveillance capitalism and the deployment of algorithms of oppression (Noble, 2018) that reinforce racist and sexist patterns of exposure, invisibility, and marginalisation (Chun and Barnett, 2021; D’Ignazio, 2024).

Like many forms of tech-enabled discrimination, harms from ad targeting disproportionately affect marginalised groups, often reinforcing existing inequalities in areas such as financial services, employment, and housing. This can also include targeting vulnerable people with issues such as gambling addiction or mental health concerns (Dent, 2025). The lack of transparency makes it nearly impossible for people to understand what data is being used, for what purposes, and whether they have been unfairly targeted by advertising (Kaltheuner, 2021). The growing adoption of generative AI (GenAI) has supercharged ad tracking, leading to heightened concerns about algorithmic bias and discriminatory outcomes. Due to their scale and complexity, GenAI models are often difficult to audit and rebalance, making them prone to amplifying existing biases (Dent, 2025).

Algorithmic justice is an emerging concept that underscores the growing concern about the societal impact of AI and Big Data-driven algorithmic decision-making (Birhane, 2021). Current critical discourse targets AI, and user data collection and tracking is often a first step towards building and improving AI systems (Bucher, 2018). Although the focus of this thesis is on online tracking and its ties to corporate power (see 2.4), algorithmic surveillance is enacted by both governments and corporations (Mejias and Coudry, 2024), whose interests and agendas are often entangled.

The works referred to next emphasise efforts to acknowledge historical injustices related to data extractivism, and to mobilise for systemic accountability in pursuit of data equity and justice.

2.5.1 Destabilising Moves: Toward Data Equity and Justice

Initiatives have been proposed to ethically guide digital innovation from both academia and industry, including principles, guidelines, codes, and frameworks, particularly within AI (Floridi, 2019). Various countries are regulating the use of user data, algorithms, and computational systems. The EU has taken different actions, such as the previously mentioned GDPR, and more recently, the AI Act (‘EU Artificial Intelligence Act’, 2025), a law that will regulate the use of machine learning.

In this section, I will focus on work outside the spectrum of policy, on non-governmental organisations (NGOs) and grassroots movements.

Starting with NGOs around the world that are working towards similar goals, such as Electronic Frontier Foundation (‘Electronic Frontier Foundation’, 1990) (USA), the Centre for Internet and Society (‘Centre for Internet and Society’, 2008) (India), KICTANET (‘KICTANET’, 2007) (Kenya), Derechos Digitales (‘Derechos Digitales’, 2005) (Chile), Asociación por los Derechos Civiles (‘Asociación por los Derechos Civiles’, 1995) (Argentina) and Open Net (‘Open Net’, 2013) (South Korea).

More localised, smaller-scale interventions have also been practiced globally. The book *Public Data Cultures* (J. W. Gray, 2025) gathers a collection of strategies on ‘counter-data’. Counter-data takes a deliberate stance against the dominant narratives around data that prioritise power and profit over people, exposing the incompleteness of these interpretations and promoting alternative viewpoints. An example is ‘counter-data actions’ (Currie et al., 2016) when community members scrutinise official data by identifying limitations and obstacles to advocate for alternative and innovative approaches. Counter-data can also be a community-driven approach to critique technical infrastructure, for example, to address the challenges posed by limited broadband connectivity (Palacios Abad et al., 2022).

Another relevant reference is Data Probes (Taylor et al., 2024), technology-mediated tools that assist research participants in exploring sensor data, enabling them to examine and reflect on their current relationships with technology. In Data Probes, the designed objects themselves address concerns about connected technologies, serving as an initial step toward envisioning future technologies that aim to resolve some of the tensions and anxieties present in current products. *HCCC* shares similarities with this project in that it invites people to reflect and act against the data tracking technologies that they critique.

The publication, Counter-N (Miyazaki and Eylül İşcen, 2021) compiles essays that propose alternative modes of computing. An example includes ‘Counteralgorithmicity’ which proposes ‘alternative modes of rhythmicity, unfolding, and dancing which operate not within the dictates of capital, the market, competition, and profit-orientation but in a sort of commons-oriented, solidarity-based way’ (Miyazaki and Eylül İşcen, 2022, p. 2).

To add to ‘countering’ efforts, Borbach and Kanderske refer to ‘counter-practices’ exemplified through works of artists that critique and subvert intended processes of sensor datafication (Borbach and Kanderske, 2024). Another example is *Slow Net*, a series of experiments that investigate how slow networks can be utilised to safeguard against data-collecting entities that compromise our autonomy and shape our identities. It consists of three works, each aimed at slowing the capture of personal data, encouraging more intentional actions, and creating opportunities for idle time. The online publication *A Quick Guide to the Slow Net* provides context on the issues underlying online data collection and explores how slow networks could be used to resist data extractivism (Chou, 2019).

In *Playbook for Resistance* (Mejias and Couldry, 2024), the last chapter of the authors’ Mejias and Couldry’ book *Data Grab*, the authors expose different pathways to contest and rethink the terms and conditions under which Big Tech operates. Inspired by a framework for collective resistance by the Latinx and Chicanx activist organisation Mijiente, the authors tackle data colonialism at three parallel levels: working within the system, outside the system, and beyond the system. They identify different initiatives from citizens, activists, worker unions, cooperatives, and Indigenous communities, among others, to tackle data extraction.

To empower communities and individuals to become more resilient in their digital presence, the Berlin-based organisation Tactical Tech created and distributed educational resources. An example is The Data Detox (Tactical Tech, 2016a), a toolkit that provides step-by-step guidance to reduce online traces. Provided in 30 different languages, the toolkit invites the user to take control of their digital privacy, security, and well-being. Tactical Tech also produced *Me and My Shadow*, a guide on how users can minimise their digital traces (Tactical Tech, 2016a).

In 2014, the same organisation launched an open-source project Trackography that shows 2,500 media websites and the network infrastructure that feeds into online tracking across 38 countries around the world. In addition, there is an analysis of the privacy policies of the companies involved. The project results have been published as an interactive map connecting the main companies involved in online tracking and their geographical locations. This project asks who has access to user data when in transit before it reaches its destination, and which jurisdiction applies (Tactical Tech, 2014).

The work developed by Tactical Tech is aimed at general users, as well as educators, researchers, libraries, museums, and other groups and individuals who want to promote digital and media literacy. The *HCCC* scores are inspired by this work and outreach (see Chapter 7). *HCCC* differs from the work by Tactical Tech in that it does not provide step-by-step advice; it inspires personally meaningful and tailored courses of action to reduce tracking.

Some organisations build software products that improve user privacy when browsing the web, such as Duck Duck Go (DuckDuckGo, 2008) and the non-profit Tor Project (The Tor Project, 2006), which provides crypto-based privacy-enhancing technologies (PETs).

In addition, browser extensions became popular among Internet users due to their easy integration into Web browsers (Martin et al., 2001). These include plug-ins such as Ad Blockers that prevent advertising from loading on webpages or plug-ins that provide default settings to maximise privacy without requiring user knowledge. Despite the implementation of these tools, users continue to face challenges in evaluating their effectiveness (Schaub et al., 2016), often relying on trust. This trust can lead to over-reliance and unrealistic expectations, which can be damaging when extensions fail to deliver as promised (Windl et al., 2025).

MindYourPrivacy is a system that visualises third-party web tracking and identifies packets that infringe on users' privacy (Takano et al., 2014). Although efforts to increase transparency through visualisations and metrics have shown promise, they often fail to produce the desired results, as users tend to prioritise trust over informed understanding of online protections (Starov and Nikiforakis, 2018; Takano et al., 2014).

Finally, the Mozilla Foundation created a guide called **Privacy Not Included* to help consumers make better informed decisions when using web services and apps, by applying warning labels to products that do not protect users' privacy and security (Mozilla, 2017).

The works referenced above provide resources for users to grow literacy

and critical reflection on data and surveillance. The next section will focus on work that centres bodies within algorithmic awareness and criticism.

2.5.2 Centering Bodies in Algorithmic Awareness and Criticism

Central to *HCCC* is the understanding of embodiment as physical engagement grounded in and emerging out of everyday experience (Dourish, 2001). It uses body-centred approaches to grow an understanding of the actions we perform and the computational systems with which we interact (Klemmer et al., 2006). Specifically, *HCCC* uses choreography and embodiment to increase awareness of how online tracking algorithms operate in digital services.

There has been a growing interest in incorporating embodiment and sense-making approaches as a means of improving algorithmic awareness within HCI (Hemment et al., 2019; Kaur et al., 2022; Long et al., 2023).

An example that specifically incorporates dance is Somatic Data, which uses somatics to represent data graphs (Perovich and Zizzi, 2024). That work involved professional dancers who were tasked with devising choreographed sequences that would allow individuals to physically experience the data through movement. Another example is the work by Backhouse et al., who made use of a physical theatre technique — Forum Theatre, by the above-mentioned Augusto Boal — to involve audiences in reflecting on the impact of engagement-based algorithms (Backhouse et al., 2023). The authors describe engagement-based algorithms designed to boost platform engagement by prioritising content that will provoke a user’s reaction, such as ‘liking’ or ‘sharing’ types of interactions (Backhouse et al., 2023). The authors demonstrate how the Forum Theatre is an effective tool to increase algorithmic awareness. Also inspired by performance techniques and the improvisation work of Boal, K. Andersen and Wakkary developed workshops that engage participants in novel and personal ways to reflect on their relationship to technologies (K. Andersen and Wakkary, 2019).

In a similar vein, Bhargava et al. introduce the concept of *Data Theatre* as an entry point to growing data literacy by engaging participants emotionally in the embodied performance of data stories (Bhargava et al., 2022).

Another example of an embodied approach to engaging with algorithmic transparency is Pothong et al.’s use of performative methods. Specifically, they employed Live Action Role Play (LARP) to support participants’ examination of the possibilities and repercussions of transparency and information visibility (Pothong et al., 2021).

An approach that incorporates immersive theatre is the project *Embodying the Algorithm*, in which a group of performers embodied algorithmically produced instructions (Jones et al., 2023). The authors investigated how embodiment can be a useful lens to examine Large Language Models, such as GPT-3, and their lack of consideration for human bodies.

Similarly, *Quantified Self* is an immersive theatre experience that combines design fiction and user enactments to engage audiences in the discussion of technology ethics (Skirpan et al., 2018). For each performance, audience

members supply their social media data (e.g., Facebook or Twitter) to shape a personalised experience where they interact with performers and technological artefacts in the performance setup.

Another influential project is *The Voices and Voids* project (Desjardins, Psarra et al., 2021) that investigates voice assistant systems and data through a series of interconnected experiments in art, design, and percussion. One of the contributors to this project was the above-mentioned choreographer, Kate Sicchio, who generated a movement score that explored the possibilities of embodying the voice assistant data logs. Sicchio choreographed two sequences of movements to be performed following Amazon Alexa voice commands. Like a duet between human and machine: “i.e. if Alexa says ‘Set an alarm for 3 minutes’ the performer must move their hands three times...” (Desjardins, Psarra et al., 2021, p. 7). This work reflects on agency in automated AI systems by inverting the roles and making the machine command the action of the human. Similarly, *HCCC* invites people to engage in a series of scores (see Chapter 7) to embody and reflect on different aspects of online tracking.

Sarah Fdili Alaoui developed a performance called *RCO* (Alaoui and Matos, 2021) that creates situations where dance and technology converge, asking both participants and artists to respond to instructions on their mobile phones. Although *RCO* does not explicitly focus on online tracking, it more broadly asks those involved to reflect on social and technological norms. It also provides a means of resisting and breaking free from these influences, offering alternative perspectives using humour and irreverence.

Another example is the piece *Data Sensorium*, which uses dance to visually convey environmental migration data (Derry, 2023). Through choreographed gestures symbolising various disasters and spatial movements representing population displacements, the performance offers both dancers and viewers a visceral and visually engaging experience.

The research referenced so far bridges embodiment with performance practices, including dance and physical theatre, to increase data literacy and critical reflection on data and surveillance. More broadly in computational arts and performance, various artists have been bridging embodied, performative, and participatory methods to critique algorithms and computational processes in society.

The DoxBox Trustbot (Gentry, 2018) is a mobile, digital puppet device designed to conduct interviews with users about their interactions with various apps and digital services. It detects the extent of information these providers have about their users and shares stories about the potential consequences of this knowledge. It also offers recommendations on the trustworthiness of these entities, considering both the individual user and others who might be affected to varying degrees by the collection and potential misuse of their digital data. Another example is the initiative *Cryptodance* (bolwerK et al., 2016), which hosts events with the intent to collectively reflect on privacy, safety, and surveillance through embodiment and dance.

The Critical Coding Cookbook (Xin and Moriwaki, 2022) is an open-source educational resource with critical approaches to computation. In particular,

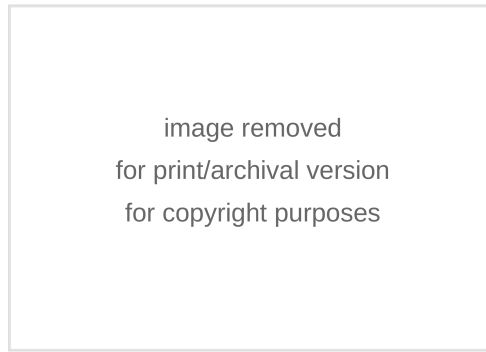


Figure 2.7: Lee McCarthy, L. (2022) *Score for Performing User*. Available at: <https://criticalcode.recipes/contributions/score-for-performing-user> (Accessed: 05 June 2025)

the artwork *Score for Performing User* (Lee McCarthy, 2022) (see Fig. 2.7), a series of instruction-based exercises created by Lauren Lee McCarthy, invites users to reflect on privacy, ethics, and justice in online environments.

Our Data Bodies (ODB) created the Digital Defense Playbook (ODB, 2019) to gather educational activities focused on data, surveillance, and community safety for people to co-create and share knowledge, analysis, and tools for data justice and equitable data access. One of the activities in the playbook consists of asking users to draw a body outline. They are then asked to write inside it the intimate data collected about them and outside the types of services or organisations that might collect those data. My approach to prompting reflection about personal data extraction shares similarities with the ODB approach, first in creating an explicit relationship between data and bodies, second in guiding that relationship towards thinking about users' proximity to data, and third as a critical device to question data extraction. Although both *HCCC* and ODB privilege a body-centric and visceral understanding of personal data; *HCCC* explores various formats beyond workshops, such as live performance (see Chapter 5) and scores (see Chapter 7).

These previous works developed strategies for integrating bodies and physical movement to make digital and often abstract processes more tangible. As such, they share efforts similar to those in the work presented in this thesis. Indeed, they are choreography-inspired and movement-led works that pay special attention to day-to-day gestures to reflect on agency, or lack of agency, within control systems. *HCCC* adds to this body of work by integrating embodied sense-making to prompt participants to enact physical and choreographic actions (for example, standing up or making gestures). In doing so, participants embody concepts related to online tracking, to grow awareness, and provoke reflection on user agency (or lack thereof).

2.6 Conclusion

This chapter maps various approaches in HCI and computational arts that use embodiment to grow awareness of algorithms and their effect on society. It presents different proposals on how to navigate the complexities of revealing and concealing algorithmic processes in a time when technological development

is driven by corporate interest and surveillance capitalism (Zuboff, 2015).

In addition, this review looks at the potential of combining approaches from artistic practice, such as live coding, that bring audiences closer to the algorithmic processes to which they are exposed day-to-day. There is an opportunity to explore how these formats and communities of practices interconnect and their potential to raise awareness of current concerns, such as online tracking.

Human-Computer Counter-Choreographies expands on this prior work by viewing the extractive nature of online tracking through the lens of choreography and embodiment. The following chapters will introduce the design of the work and the studies that guided my research practice.

Chapter 3

Methodology

3.1 Introduction

This chapter explains the research methods used in this thesis and how they relate to the research goals. My high-level goal from the beginning of my PhD was to investigate how choreographic and embodied approaches raise awareness of data tracking (see Chapter 1.3 for research questions).

My investigation process combined artistic research (Section 3.2.1), critical practices (Section 3.2.2), and embodied and choreographic approaches (Section 3.2.3) to support my practice-based research (Candy, 2006).

In addition, I present key research activities (section 3.3): redesigning a browser extension, a performance piece, a workshop series, and a digital artwork featuring a collection of scores presented at a final exhibition. The design and production of tools and activities were carried out iteratively, after reflecting on the data collected and analysed in each study (Section 3.3). Empirical studies included questionnaires and semi-structured interviews with audience members and community stakeholders to investigate their impact.

3.2 Overarching Research Methodology and Approaches

Human-Computer Counter-Choreographies uses a methodology that borrows from artistic research, critical practices, choreography, and embodiment. This section provides an overview of how these methods influenced this research; each subsequent chapter further details how these were deployed.

3.2.1 Artistic Research

I followed an artistic research methodology (Borgdorff, 2010) that prioritised conceptualisation and experimentation through the design of tools and activities that aim to raise awareness of online tracking algorithms. I did so through an iterative process using choreographic and embodied methods and documentation of the practice involved.

An artistic research approach is based on the development of knowledge that emerges from reflection through the creative practice of the author. The research is reported from the author’s meaning-making process, embracing

a first-person perspective. First-person methods in HCI include autoethnography, autobiographical design, and autoethnographical research-through-design (Lucero et al., 2019). They allow the researcher, designer, and author to continuously create, construct, and/or use their own designs (Desjardins, Tomico et al., 2021; Joshi et al., 2024). They involve placing the researcher at the heart of their design process and the lived experience of utilising a system.

Zhang and Wakkary assert that it is undeniable that designers use and benefit from their personal experiences in their design practice (Zhang and Wakkary, 2014). They advocate for acknowledging the legitimacy of designers' experiences in interaction design, whether these experiences involve observing real-life events or interacting with artefacts and systems. Thus, first-person methods demonstrate the importance of researchers' personal experiences in gaining deep and long-term insights into experiments and designs of systems within the field.

My work aligns with such methods. I present artistic research based on an autobiographical process that led me to produce a series of works – browser-based tools (Chapter 4), a performance piece (Chapter 5), workshops (Chapter 6) and a digital artwork showcasing a collection of scores (Chapter 7 and 8) – that use embodied and choreographic approaches to reveal online tracking. I believe that a detailed description of my creative journey sheds light not only on the process of creating my work, but also on how it promotes algorithmic awareness and criticality.

As a performer, designer, researcher, and lecturer, my experience in the design of the works and the questions it raised for my practice were central to my inquiry. The initial choices of work format, for example, to produce a live-coding performance, emerged from my ongoing work within that community of practice. Moreover, my choice to focus on the browser as a medium revolved around my practice of repurposing existing technical artefacts as a form of critique (described in Chapter 1.1, also elaborated in Section 3.2.2). Similarly, my choreographic references are tied to my background in dance and interests in the use of choreography as an embodied approach to reflect on and engage in the critique of social issues (see Section 3.2.3).

In line with the concept of situated knowledge (Haraway, 1988), it is also essential to acknowledge that my dance education has endowed me with a deep familiarity with movement, a comfort level that may not be shared by people without prior experience in somatic practices or dance. When designing activities, this understanding guided my choice of movements, favouring simple and intuitive gestures such as drawing or hand gestures such as clapping that were easily reciprocated by participants. The decision on which physical tasks to include was a deliberate part of an iterative process, built on my experience facilitating embodied exercises outlined in this thesis (see Section 3.2.3). Through my first-hand experience facilitating various studies, diverse perspectives from participants were aggregated, thereby contributing to the development of a cumulative understanding of the potential of counter-choreographies.

The reliance on my artistic practice, such as my long-standing engagement

with choreography or my familiarity with formats such as live coding, may be seen as limiting the scope of exploration. What would have been left to explore is unknown, but the benefits are clear: it led to a deep and long-term understanding of the design of the work and reflection on its impact on people (Chapter 9). On the other hand, the design and production of browser-based tools (Chapter 4), performance piece (Chapter 5) and workshops (Chapter 6), led to the production of a collection of scores hosted on a website (Chapter 7) a new form of documenting my practice.

The artistic research process was porous (as seen in Fig. 3.1), and the different works were interconnected. The materials created as part of one work were modified and transposed to another. An example of this was the use of the browser extension in the performance, which later became part of the workshop. I presented a shorter demo of the browser extension during workshops, which proved to be an effective way to demonstrate the prevalence of online tracking. In addition, the programming scripts developed for the performance (see Chapter 5.2.4) and some choreographic prompts designed for the workshop (see Chapter 6.2.3) formed the basis for the collection of scores and the design of the website where it is hosted (Chapter 7). The production of works within my artistic practice was informed by one another, while responding to the broader methodological approaches outlined in this chapter.

3.2.2 Critical Practices

In the fields of art, design, and computer science, there is a legacy of methods and approaches for critically reflecting on technological artefacts and their impact on society (Bogers and Chiappini, 2019). A seminal reference is Critical Technical Practice (CTP), first introduced by Agre (Agre, 1997) in the context of research and development in Artificial Intelligence (AI). According to Agre, CTP is defined as a situated, practical, and constructive approach to work that inherently incorporates critical reflection. Furthermore, CTP views technology development as a means of critically examining the underlying assumptions and attitudes that shape the relationship between technology and humanity (Dourish et al., 2004). As a result, various communities of practice have adopted, adapted, and applied CTP approaches in diverse contexts, including human-computer interaction (HCI), media art, and pedagogy (Van Geenen et al., 2024).

Similarly, in Research through Design (RtD) in HCI, research artefacts are seen as catalysts ‘for discourse in the community, with each new artefact continuing the conversation’ (Zimmerman et al., 2007, p. 6). RtD is a research practice in which the design of a product, system, space, or medium is the vehicle to build knowledge (Koskinen et al., 2011). One form of RtD is Critical Design (Dunne, 2008; Dunne and Raby, 2021) that explores design values that prioritise ethics and bring about social change. It encourages users to critically assess their daily lives, especially how assumptions, values, ideologies, and behavioural norms are embedded in designs that mediate their lives. Intrinsic to Critical Design is seeking change and proposing alternative perspectives to

cultural, social, economic, and technical norms and expectations (J. Bardzell and Bardzell, 2013). The concept of ‘counter-choreographies’ proposed in this thesis builds upon this criticality. It both facilitates the critique of data extractivist technologies and leads to user behavioural change towards such technologies.

In both Critical Technical Practice and Critical Design, artefact production is a chance to engage critically in research. To exemplify, the custom web extension (described in Chapter 4) exposes online tracking through visualisation and sonification of tracking requests. The main goal of redesigning the extension and developing additional scripts was to increase awareness of tracking, and this constitutes its primary value as a technical tool.

This critical approach guided the design of the performance piece dramaturgy (Chapter 5.2.4) that gradually exposes online tracking techniques on the web browser in real time to the audiences. It also guided the design of workshop tasks (Chapter 6.2.3) and the creation of the score collection (Chapter 7.2) that invite users to critically reflect on the prevalence of online tracking and inspire user behavioural change. It achieves this by encouraging users to analyse their everyday online gestures and connect them to online tracking. The following section details how my critical approach incorporates embodied processes.

HCCC connects with a lineage of practices that invite critical and creative engagements with data as a cultural, social, and political medium (Dieter, 2024; Van Geenen et al., 2024), in the hope that they may inspire re-imagining of data-driven technologies.

3.2.3 Embodied and Choreographic Approach

Sense-making refers to the process of understanding one’s environment as a situated activity (echoing Chapter 2.2.2). In HCI, it has been described as collaborative, embodied, and/or participatory (Smit et al., 2022). In this thesis, I combine autoethnographic methods in the design of the work (see Section 3.2.1) with participatory ones in empirical studies, which involve people (see Chapters 5; 6; 7). In the performance and even more so in workshops, it has been through shared embodied experiences that people collaboratively constructed what counter-choreographies meant to them.

As mentioned in the contextual review (Chapter 2), HCI has seen an increase in interest and attention to embodied sense-making, felt experiences, and tacit knowledge. Established methods include embodied engagement (Wilde et al., 2011) and bodystorming (Hook, 2018), among other examples drawn from theatre and performance practices (Iacucci and Kuutti, 2002; Newell et al., 2011), live action role playing and scenario enactment (Burns et al., 1994; Pothong et al., 2021). These methods emphasise the generative and creative potential of physical involvement through learning by doing or using physical movement (Loke and Schiphorst, 2018).

In my work, I specifically draw on the practice of choreography, and a detailed account of the references that influenced *HCCC* is provided in the Chapter’s section 2.2. As mentioned in Section 3.2.1, this choice is groun-

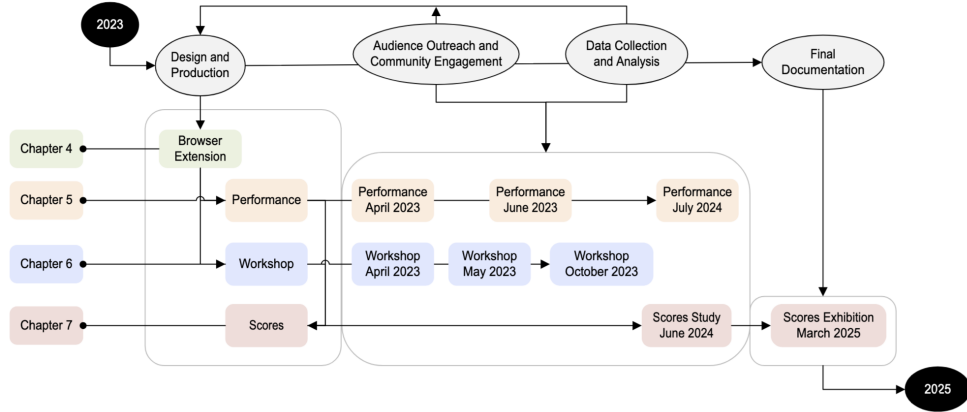


Figure 3.1: Key research activities during the PhD journey.

ded in my background and artistic practice. An example of a choreographic technique is the design of scores for participants and audience members to respond through physical enactments (such as standing up or making hand gestures). I guided people to embody concepts related to online tracking, to grow awareness, and to provoke reflection on user agency (or lack thereof).

Given that the scores were designed for anyone to perform (including non-dancers), the choices of movement were kept as familiar and simple as possible. This is in line with the references that shaped my work (see Section 2.2) that prioritised mundane, ‘day-to-day’ movements over movement intricacy. In addition, following the legacy of the works that inspired *HCCC*, I use choreography to connect to political and social issues. This ties with the above-mentioned critical aspect of my work (see Section 3.2.2). In this vein, embodiment and choreography are employed in my work to foster greater awareness, reflection, and understanding of online tracking.

3.3 Intertwined Nature of the Key Research Activities

The ultimate goal of this research is to find novel relationships between choreography and data tracking to raise awareness of extractivist technologies.

As can be read in Fig. 3.1, the initial research activities (performances - Chapter 5 and workshops - Chapter 6) were designed and hosted in parallel. Each influenced the development of the other and brought me one step closer to addressing my research questions (see Chapter 1). Both the performances and the workshops allowed me to explore how the choreographic approach I used contributes to engaging people in a critical reflection of online tracking in their lives. Both formats integrated choreography and embodiment in the critique and awareness of online tracking algorithms.

The workshops went a step further, it included activities (described in Section 6.2.3) that explicitly invited participants to generate ideas to counter it. On the one hand, workshops allowed me to explore participation and consensus-building within group exercises and collective discussions. On the other hand, the performance allowed me to connect with a larger audience and

devise tactics to communicate in that particular set-up through live coding.

The artwork showcasing the *HCCC* scores (see Chapter 7) was designed to investigate in greater detail how counter-choreographies led people to behavioural change. These required the design of a longer-term experience that could be customised and adapted to the daily routines of people. The basis for the creation of the scores was the exercises developed for the workshops. In addition, some of the scripts developed for the performance were integrated into the design of the *HCCC* scores website. The scores allowed me to further develop a ‘choreographic vocabulary’ that invites reflection on online tracking. Moreover, the 12 scores comprehensively address aspects of online tracking that the performance and workshop could not cover in such detail due to time constraints. Finally, the scores operate independently, for example, in the intimacy of the home, without the need for facilitation.

Finally, the exhibition allowed me to bring together the work developed throughout as part of the performance piece, workshop series, and score’s website to a broader public.

The next chapters dive deeper into the design, production and empirical findings of all research activities presented in Fig. 3.1.

Chapter 4

Browser Extension

4.1 Introduction

The DuckDuckGo app ('DuckDuckGo', 2020) is an extension that offers a set of built-in functions to search the Web privately without being tracked. It uses a tracker blocker technology called third-party tracker loading protection, which automatically prevents most cookie requests from loading. It also helps prevent fingerprinting by blocking attempts to combine information about the user's browser and device settings, ultimately hindering companies from creating a unique identifier.

Cookie requests and fingerprinting are the most common online tracking techniques used by ad services (Kretschmer et al., 2021). I designed a custom version of the DuckDuckGo extension to expose these online tracking techniques during performances (Chapter 5) and workshops (Chapter 6).

The original version of the extension discreetly holds information about the trackers' names after clicking on the respective icon on the browser navigation bar (see Fig. 4.1). I was interested in emphasising and revealing more information about the trackers that were intercepted by the extension. To do so, I mapped each tracking request to audio and visual feedback, among other modifications. In the next sections, I explain the process of modifying the web extension.

4.2 Methodological Approach

4.2.1 Artistic Research

The work described here is part of an artistic research methodology (Borgdorff, 2010) based on an autobiographical process that led to the production of a custom web extension.

Throughout the research process, the extension was installed in my browser, allowing me to simultaneously develop and experience the tool as both a maker and a user. This aspect aligns with artistic research methods (see Section 3.2.1), such as autobiographical design, where designers explore and interact with systems to gain insight into their creative practices (Lucero et al., 2019). I believe that a detailed description of my creative journey sheds light not only on the process of customising the browser extension but also on how the

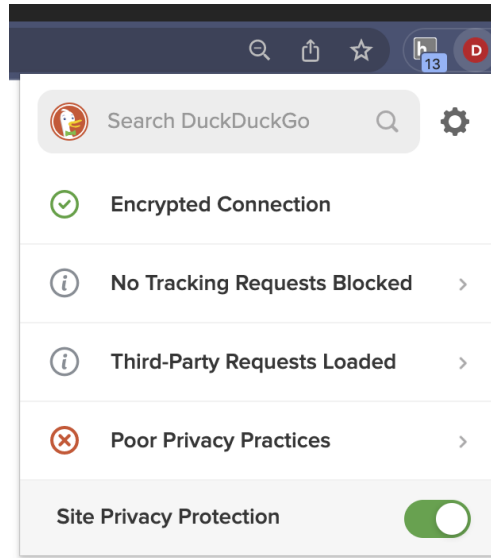


Figure 4.1: Screenshot of DuckDuckGo’s original pop-up window displaying tracking information in the browser (2023).

process itself was guided by the goal of promoting algorithmic awareness and critique.

4.2.2 Critical Technical Practice

The tool design process drew from Critical Technical Practice (Agre, 1997) in its commitment to critical engagement beyond the technical aspects.

I designed the extension to sensitise people and make abstract concepts related to data tracking more tangible, visceral, and embodied. Specifically, I integrated audiovisual feedback to engage people in reflecting on the impact of online tracking technologies on their lives. To this end, there was less concern for the code in achieving a specific practical goal other than raising critical awareness.

The next Section 4.3 details the Critical Technical Practice employed in developing the web extension, specifically the integration of critical reflection with its technical aspects.

4.3 Tool Design

4.3.1 Initial Process Log

I started by investigating online tracking techniques in browsers, web analytics services, and existing privacy-enabling tools (including the DuckDuckGo web extension) in separate log files.

In the first file, I documented my initial research on web browsers (such as Chrome, Firefox, and Tor) and how much information could be inferred from each of them regarding tracking requests. Of the three listed browsers, Tor (The Tor Project, 2006) offered the most protection, although it operated by default, and did not provide comprehensive information on tracking requests. Additionally, to learn more about tracking techniques, I collected examples of scripts that extract user data from websites such as ‘Am I unique’ that provide

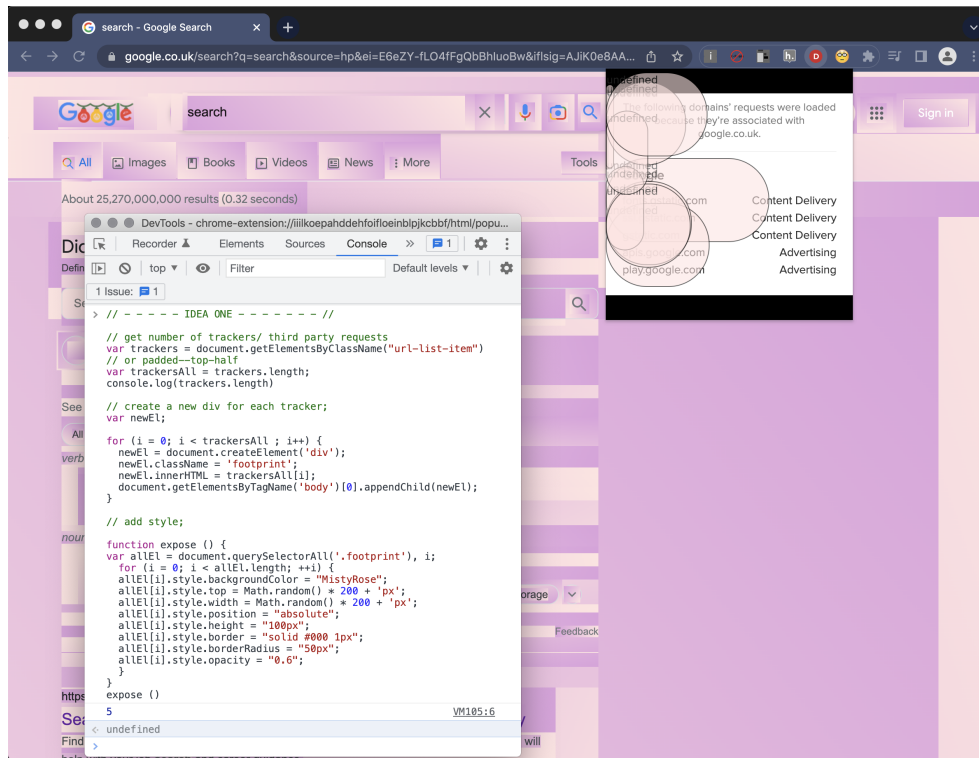


Figure 4.2: Screenshot of an early exploration of styling the webpage and DuckDuckGo extension (2022).

information on browser fingerprint properties (Inria, n.d.). It included browser and device identifiers, commonly tracked by online services. These scripts were tailored to the performance in the section dedicated to revealing fingerprinting techniques (see 5.2.4).

Secondly, I chose to investigate Google Analytics (Google, n.d.), one of the most prevalent web analytics tools (Williams, 2018). I took notes from Google Analytics online documentation and my experience creating an account in the same service. The insights from this research informed the performance and workshop materials, such as the reference to user profiling and ‘audience’ categorisation (see Sections 5.2.4 and 6.2.3).

In the third file, I investigated existing privacy-enabling tools, such as browser extensions, such as the Privacy Badger created by the Electronic Frontier Foundation (Electronic Frontier Foundation, 2017). Other relevant references that improve privacy while browsing online are mentioned in Section 2.5.

I decided to work with the open-source DuckDuckGo privacy extension (DuckDuckGo, 2018) in the Chrome browser, as it seemed to be a malleable and well-maintained tool, providing more granular information on tracking requests compared to other choices. I recorded the process of reading the online documentation and taking notes from the DuckDuckGo website and the code repository. Later, notes from the email exchange with the team were added, as described next in Section (4.3.2). I traced my attempts to change different parts of the code (see Fig. 4.2 and Fig. 4.3) until I got the desired results that led to the final design (see Section 4.3.3).

After this preliminary work, I started prototyping my version of this web

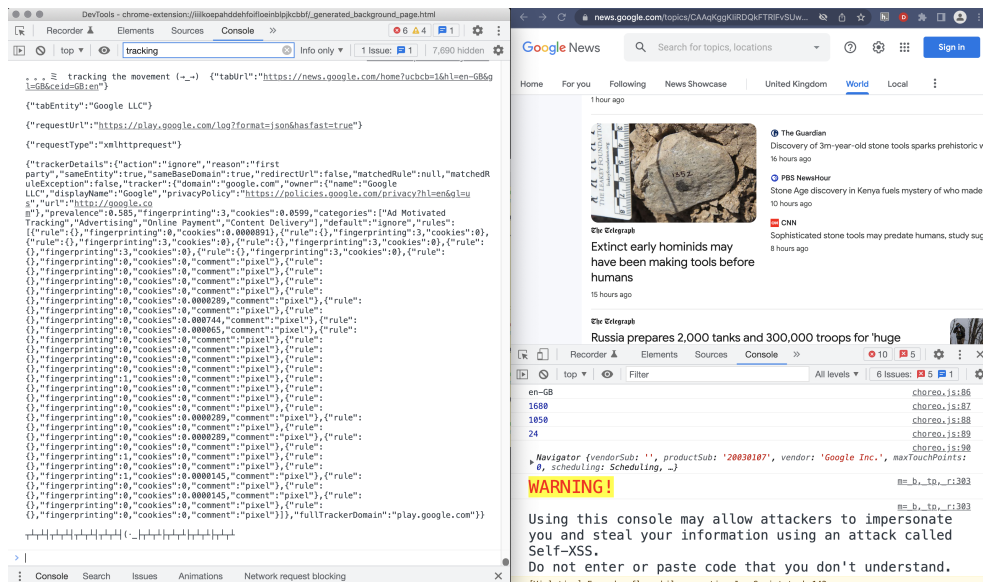


Figure 4.3: Screenshot of an initial prototype that shows a modified version of the DuckDuckGo privacy extension, which displays a list of tracker requests (left) and a webpage on the Chrome browser (right) (2023).

extension alongside additional code used in the performances (see Section 5.2.4).

4.3.2 Email Exchange with DuckDuckGo

As part of learning about the web extension, I initiated an email exchange (11/01/23 - 10/02/23) with the DuckDuckGo team (Konrad Dzwinel and Dave Vandyke), who helped me understand how to navigate the code repository. I posed them two main questions:

1. How can I access the raw data on the trackers so that I can customise their display?
2. How do I connect the web extension to the browser tab?

An answer to the first question would allow me to customise the display of information about trackers. In the original web extension, this information is displayed in a pop-up window and is filtered to show only the blocked trackers (see Fig. 4.1).

An answer to the second question would enable me to send information between the browser window and the extension. This would allow me to display tracking information in the browser tab, instead of that information being confined to the pop-up window.

Clarifying these aspects was extremely useful to me in proceeding with my work.

On 13 July 2023, I had a meeting with Konrad Dzwinel and another software engineer at DuckDuckGo, Samuel Macbeth. In this call, they mentioned that at DuckDuckGo, there have been efforts to make the results of the web extension more visible to the user. For example, on the mobile version, a notification pops up at the end of the day with the total number of blocked

trackers. They added this functionality to grow user awareness of the prevalence of online tracking and the effectiveness of the tool in preventing it. They also explored more playful approaches, such as flooding the web interface with colourful circular elements that would block the content view as tracking requests piled up. This was particularly interesting to learn about, as it shares commonalities with my approach to visual design applied to the performance piece as elaborated in Section 5.2.

On 7 December 2023, I presented at Random Acts of Learning, an online lecture series at DuckDuckGo, where I had the opportunity to share my work-in-progress with the broader team and staff.

4.3.3 Final Design

The research described earlier led to the final design of the browser extension.

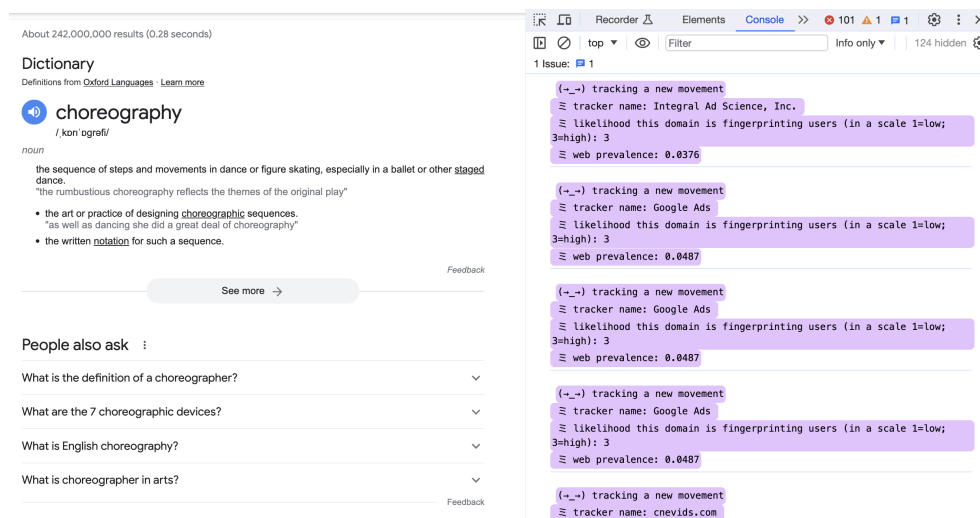


Figure 4.4: Screenshot of a webpage with the Chrome browser web console open on the right side, displaying the DuckDuckGo privacy extension adapted and developed to display tracking requests (2024).

I designed this extension for use in live demonstrations (see Chapters 5 and 6). The browser window was divided into two sections (Fig. 4.4): the left side displayed the websites being navigated, while the right side showed the web developer tools. This configuration enabled me to run and modify code on the developer tools (right side), which then displayed in real-time on the browser interface (left side).

The sonic and visual design featured a persistent metronome rhythm and a distinctive pink colour scheme ¹. I mapped each tracker request to the sound of a single metronome click. I chose the metronome's sound, which is commonly used to set rhythm and synchronise dance movements. The sound can play repeatedly depending on which page is visited and the corresponding number of tracker requests. Tracker requests can occur in various instances, such as when loading or interacting with content, determined by the extent of tracking deployed on a website. The idea behind it was to create a continuous rhythm that emphasises the presence of online tracking.

¹see video demo of the browser extension: <https://ualresearchonline.arts.ac.uk/id/eprint/24309/> (Accessed August 2025).


```

1 // - - - - TRACKING ACTIVE CODE - - - - - //
2
3 // code to list tracking requests in the web console of the main tab:
4
5 let timer;
6 let bg;
7 var track
8
9 chrome.runtime.onMessage.addListener(function(request){
10 // uncomment the line below for full tracking details:
11 // console.log(request)
12 setTimeout(console.log.bind(console),
13   '\n %(<-) tracking a new movement' + '\n ≡ tracker name: ' + request.tracker.tracker.owner.name +
14   '\n ≡ likelihood this domain is fingerprinting users (in a scale 1-low; 3-high): ' + request.tracker.tracker.fingerprinting +
15   '\n ≡ web prevalence: ' + request.tracker.tracker.prevalence, "background:#e5c0ff;color:#000;padding:2px;border-radius: 5px;line-height: 16px;"
16 ));
17
18 // code that changes background colour for each tracker request:
19
20 if(bg === undefined){
21   bg = document.body.style.background + document.body.style.border;
22   console.log(bg)
23 }
24
25 document.body.style.background = "linear-gradient(" + Math.floor(Math.random() * 360) + "deg, #e5c0ff, #af3eff, #e5c0ff, #e5c0ff, #9500ff)";
26 clearTimeout(timer);
27
28 // code that plays the metronome sound for each tracker request:
29
30 timer = setTimeout(() => {
31   document.body.style.background = bg;
32   audio = new Audio(chrome.extension.getURL('/public/audio/metronome-cut.mp3'));
33   audio.play();
34 },
35   1
36 )
37 });

```

Figure 4.5: JavaScript code that displays tracking requests and triggers audio and visual feedback (2025).

The pink-coloured theme allows me to differentiate the custom code and the added content to the interface. For example, whenever a tracker request is identified, the webpage’s background flashes pink. Moreover, for each new tracking request, the tracker info is displayed on the web console on a pink background (as seen in Fig. 4.4), adding to a list that grows as I navigate the Web. Information on the tracker includes its name, the likelihood of fingerprinting and the tracker’s prevalence on the Web. These are provided by DuckDuckGo’s open dataset (‘DuckDuckGo’, 2020), but they do not display as default in the original version of the extension. The latter allows people to notice third-party trackers from companies external to the webpage and provides context around how prevalent those trackers are.

Figure 4.5 shows the code function that lists the trackers in the web console, plays the audio, and triggers a background colour each time a new tracker is detected. These functions are stored in a file named ‘choreo.js’² with my additional code functionalities.

I created additional programming scripts³, written in JavaScript, that introduce tracking techniques in addition to tracker requests, such as fingerprinting, and user interactions. These are an integral part of the performance piece as described in Chapter 5. Figure 4.6 shows an example of a script designed to draw attention to fingerprinting. The script makes visible the data commonly extracted from the user’s browser and operating system by displaying them as an overlay on the browser window.

Each JavaScript function I have created is named after choreographic concepts. The code function exemplified above is named after Trisha Brown’s *Accumulation* piece. I took inspiration from the choreographic concept of accumulation developed in her 1971 performance *Accumulation* (Rosenberg,

²File ‘choreo.js’ available at: <https://gitlab.com/hc-cc/human-computer-counter-choreographies/-/blob/main/shared/js/content-scripts/choreo.js> (Accessed June 2025).

³Folder ‘live-scripts’ available at: <https://gitlab.com/hc-cc/human-computer-counter-choreographies/-/tree/main/live-scripts> (Accessed June 2025).

```

14 // FINGERPRINTING
15 // function 'accumulation' lists data commonly extracted:
16
17 var delay = "2";
18 var count = '0';
19 var print = new Array();
20 print[0]='onLine: ' + navigator.onLine;
21 print[1]='Language: ' + navigator.language;
22 print[2]='Location: ' + location;
23 print[3]='time: ' + new Date();
24 print[4]='browser and operating system: ' + navigator.userAgent;
25 print[5]='screen width: ' + screen.width;
26 print[6]='screen height: ' + screen.height;
27 print[7]='screen orientation: ' + screen.orientation.type;
28 print[8]='screen available width: ' + screen.availWidth;
29 print[9]='screen available height: ' + screen.availHeight;
30 print[10]='screen color depth: ' + screen.colorDepth;
31 print[11]='screen pixel depth: ' + screen.pixelDepth;
32 print[12]='locationbar visible: ' + window.locationbar.visible;
33 print[13]='menubar visible: ' + window.menubar.visible;
34 print[14]='scrollbars visible: ' + window.scrollbars.visible;
35 print[15]='statusbar visible: ' + window.statusbar.visible;
36 print[16]='toolbar visible: ' + window.toolbar.visible;
37 print[17]='cookies enabled? ' + navigator.cookieEnabled;
38
39 function accumulation () {
40   var fingerprinting = document.createElement("p");
41   document.getElementsByTagName('body')[0].prepend(fingerprinting);
42   fingerprinting.classList.add("traces");
43   fingerprinting.innerHTML = ' language: ' + navigator.language;
44   fingerprinting.style.position="absolute";
45   fingerprinting.style.top="0";
46   fingerprinting.style.font= "bold 10vw monospace";
47   fingerprinting.style.textShadow= "2px 2px 3px #c4c3d0";
48   fingerprinting.style.zIndex= "99";
49   fingerprinting.style.color= "#af3eff";
50   fingerprinting.style.opacity= "0.3";
51   fingerprinting.style.pointerEvents= "none";
52
53   fingerprinting.innerHTML=print[count];
54   console.log('%c ' + print[count], 'color: #9500ff;');
55   count++;
56   if(count==print.length){count='0';}
57 }
58
59 datapoints = setInterval(accumulation, 2000);
60 // clearInterval(datapoints);

```

Figure 4.6: JavaScript function named ‘Accumulation’ (2025).

2012). In this piece, Brown stands on stage and builds up a choreography, starting from the first step and adding one more step each time she repeats the choreography. As tracking accumulates, such accumulation is visible in both the browser and in the long list of tracker requests in the web console.

This practice of adding syntax and meaning to standard functional or procedural programming is called Esoteric Programming (Temkin, 2022b) – further referenced in Section 2.3.2. In *HCCC*, the code vocabulary combines computer code and choreography as a means to explore new aesthetic expressions outside the conventions established within computational systems. The added comments (‘//’) and the name of the code functions help guide the audience to understand what the code does, both at a technical and conceptual level.

The complete documentation of the code and adapted version of the browser extension are available in an online repository ⁴ and are open-source, which is in line with views strongly present within the live-coding community.

4.4 Discussion

My research on how online tracking works started with an investigation of web browsers, web analytics techniques, and existing privacy-enabling tools as described in Section 4.3.1. My goal was to understand online tracking better by engaging directly with native Web tools and developing familiarity through the creation process.

In line with Artistic Research’s autobiographical processes, the browser extension has been used by me, the maker of the tool. Throughout the de-

⁴Link to repository available at: <https://gitlab.com/hc-cc/human-computer-counter-choreographies> (Accessed June 2025).

velopment of this work, I installed my modified version of the extension in the Chrome browser on my personal computer. This allowed me to regularly experience audio-visual feedback, providing insights into which websites employed the most tracking, which informed my website selection for performances (Chapter 5) and workshops (Chapter 6). However, the feedback was sometimes overwhelming, making browsing difficult. This sparked my curiosity about the potential reactions of other users if they were to adopt this tool, as I expand in Section 4.4.1.

The browser extension’s real-time audio-visual feedback on data tracking provides a sensory experience for tracking requests and measurements. By doing so, it complements the work referenced in 2.3.4, such as plug-ins *GoogleTeller* (Hubert, 2022), *Safebook* (Grosser, 2019) and *Demetricator* (Grosser, 2017).

Although designed to raise awareness of the widespread practice of online tracking, this tool also has the potential to encourage digital services to adopt more ethical and transparent data handling practices. As mentioned above (4.3.2), the DuckDuckGo team had been working on strategies to educate users about the widespread nature of online tracking and to demonstrate the impact of the tool on protecting them. My design approach offers a model for industry professionals seeking innovative ways to illustrate the pervasive nature of online tracking. It provides visceral, embodied, and engaging approaches to communicating complex issues surrounding data privacy.

4.4.1 Limitations and Future Work

Despite the fact that the tool is not directly used by workshop and performance participants, I envision its potential for redesign as a personal, user-facing application. Future research could empirically investigate whether its use fosters reflection on online tracking practices and motivates users to challenge or resist them. Improving the user experience for personal use would require removing the dependency on browser developer tools from the current design. One way of accomplishing this would be to place the information currently listed in the web console in a visible part of the webpage.

Finally, the portability of this technology – being accessible within a web browser – allows for easy adaptation to diverse environments, potentially including hybrid online and on-site interactive art installations, to engage wider audiences.

4.5 Conclusion

This chapter describes the redesign of the DuckDuckGo browser extension and additional custom scripts to expose tracking techniques through audio and visual feedback. The process and methodology employed, rooted in artistic research and critical technical practices, are also reflected upon. By providing a sensory entry point into the experience of online tracking, this work sets the stage for the insights shared in subsequent chapters. Specifically, Chapters

5 and 6, offer an in-depth look at the experiences of audience members and participants' exposure to the browser extension.

Chapter 5

Live-Coding Performance

5.1 Introduction

The *Human-Computer Counter-Choreographies* (HCCC) performance combines live coding with choreographic methods to expose online tracking on stage. It uses custom-made programming scripts and a modified version of the DuckDuckGo privacy extension (DuckDuckGo, 2018), an open-source tool that monitors online tracking, to make trackers visible and audible on stage (see Chapter 4). Throughout the performance, the audience is encouraged to participate by following a sequence of choreographic prompts and embodying various aspects of online tracking, such as fingerprinting and profiling.

In this chapter, I present the design of the *HCCC* performance piece that aims to increase people’s awareness of online data tracking. To do so, I pose two research questions:

- RQ1: How can I design a choreographic live-coding performance that reveals data tracking algorithms in web environments?
- RQ2: How does such live-coding performance support audiences in gaining awareness of data tracking?

To address RQ1, I introduce the performance design, detailing the methodology used to create it that borrows from artistic research and critical design (Section 5.2), followed by a description of the performance design from a first-person perspective (Section 5.2.4).

After three performances of *HCCC*, and to address RQ2, I gathered the audience’s responses to questionnaires (Section 5.3.2) and analysed them using thematic analysis. The findings show that *HCCC* allowed audience members to gain awareness and engage their bodies in critical reflection on online tracking. My contribution in this chapter is two-fold. First, I present a new approach to live-coding and human-computer interaction (HCI) that bridges choreography with online tracking. Second, I share my empirical findings on the effectiveness of engaging audiences in reflecting and critiquing data tracking during the performance.

5.2 Performance Design Process

5.2.1 Intentions Behind the Performance

In line with my RQ1 (see Section 5.1), the *HCCC* performance was created to increase awareness of online tracking. The performance piece builds upon my artistic practice and engagement with live coding and its community (further contextualised in Section 1.1).

The performance design focused on three main aspects: the browser design, including the visualisation and sonification of the trackers (Section 5.2.4), the choreography of audience participation (Section 5.2.4) and the dramaturgy (Section 5.2.4). Note that choreography is not only a contained element, but also an overarching one which binds together trackers' exposure and audience participation.

5.2.2 Artistic Research

I followed an artistic research methodology (Borgdorff, 2010), described in Section 3.2.1, as part of which I created this performance piece that exposes online tracking algorithms. Similarly to research through practice, my artistic research approach is based on the development of knowledge that emerges from my creative practice and my reflections on it. Thus, the research is reported from a first-person perspective. First-person methods in HCI include autoethnography, autobiographical design, and research-through-design (Lucero et al., 2019). They allow the researcher, designer, and author to continuously create, construct, and/or use their designs (Desjardins, Tomico et al., 2021). The process involves placing myself at the heart of their design process and the lived experience of utilising a system.

In line with performance-led research in the wild (Benford et al., 2013), which involves creating work presented in the 'wild' as public performances, my experience in performing *HCCC* provided me with deep insights into its impact on my audiences. This understanding then informed my artistic research process in subsequent works, such as in Chapter 7.

In Section 5.2, I present my artistic research based on an autobiographical process that led me to produce a live-coding performance that uses custom-made programming scripts and choreographic prompts to reveal online tracking live on stage.

5.2.3 Critical Design

In the vein of Critical Technical Practice (Agre, 1997) and Critical Design (Zimmerman et al., 2007), described in Section 3.2.2, I designed the custom web extension described in Chapter 4 as a discursive artefact that provides a critical lens for audiences to reflect on the prevalence and evasiveness of the online algorithms it exposes. The motivation behind the custom web extension goes beyond the development of the technical artefact and towards sensitising audiences and making abstract concepts related to data tracking more tangible and embodied, through visualisation and sonification techniques. To this end,

there is less concern for the code in achieving a specific practical goal other than raising critical awareness.

In addition, I use a critical approach to design the participatory aspect of the performance, which consists of moments in which audience members respond to choreographic prompts with simple actions as a form of enactment of tracking strategies. These design decisions are described in Section 5.2.4.

5.2.4 Performance Structure and System Design

In this Section, I provide a first-person account of designing *HCCC* from the point of view of both the performer and maker of the performance. As part of my autobiographical design process, I documented the performance-making process by keeping written notes of the steps I went through during creation. I also collected screenshots of visual experiments alongside saved versions of code. I revisited all this material to retrace my journey in making this performance piece. In addition, all three public performances were recorded on video, making it possible to rewatch and reflect on them afterward.

Visualising and Sonifying Online Tracking

As detailed in Chapter 4, I designed a custom version of the open-source DuckDuckGo privacy extension (DuckDuckGo, 2018) that maps each tracking request to audio and visual feedback in JavaScript. During the performance, I use this extension in combination with additional programming scripts, written in the same language as described next.

For the *HCCC* performance, I designed visualisations and sonification of three tracking techniques in the browser: 1) tracker requests, 2) fingerprinting, and 3) user interactions. I chose to add sound and visual feedback to reveal them and set a rhythm to the experience of being tracked for an audience. Additionally, I chose to use the Google search engine because of its popularity with users in Europe and the USA, where the performances took place. This means that audiences can immediately identify the interface and relate to its navigation gestures. In addition, Google Corporation is at the forefront of the ad networks market, which uses tracking techniques extensively to target users with personalised content (Williams, 2018), which makes it relevant for me to expose their strategies when addressing data tracking.

First, to expose tracker requests, I mapped each request detected by DuckDuckGo's extension to the sound of a single metronome click. Depending on which page is visited and the corresponding number of tracker requests, the sound plays repetitively. Tracker requests occur in various instances, such as when content is loaded or when interacting with content, depending on how much tracking is deployed on a website. The trackers are printed on the web console in real-time, synchronised with the metronome sound, and accompanied by a flashing pink background that highlights which trackers are triggered each time. I expose these tracker requests by including their name, the likelihood of fingerprinting, and the tracker's prevalence on the web (see Fig. 5.1 and Fig. 5.2).

Second, to expose fingerprinting, I collected and adapted JavaScript code that extracts information on the user’s browser, operating system, and device. These include screen dimensions and resolution, time zone, and language preferences, among others. The more information collected, the more precise the identification of the device. To emphasise this aspect of the accumulation of users’ data, the text corresponding to each fingerprint item overlays the Google search engine displayed to the left of the screen. I set the font size to be large and with a level of transparency, so that audience members can read the initial fingerprint values, but as the items stack on top of each other, they become unreadable (Fig. 5.1).

Lastly, to expose the user interactions commonly tracked by web analytics, I created a set of code functions, for example, a visual tail connected to the cursor that emphasises the monitoring that underlies user interactions with the mouse while browsing websites. As illustrated in Fig. 5.1, the tail is visible as a series of human fingerprints. Another example is the overlay of the scroll percentage onto the webpage. As seen in Fig. 5.2, the scroll value is updated as I ‘move’ vertically on the page.

While most code functions are pre-written and assigned to a specific section of the performance, some changes to the code are made live, for example, to highlight or change the scale of the visuals on the screen. My choice to display the console relates to the principle of algorithmic transparency advocated by the live-coding community. Although my practice consists of manipulating and parametrisating pre-written code instead of writing code from scratch, it qualifies as live coding. As introduced in Section (2), there is no formal definition of live coding nor a defined measure of how much coding needs to be written live to make a live-coding performance. One of the earliest definitions of this practice refers to ‘tweaking or writing the programs’ live (Collins et al., 2003, p. 321). In fact, Blackwell et al. resist claiming a particular definition as doing so would establish control over that which is an open and evolving practice (Blackwell et al., 2022a). In *HCCC*, live coding consists of displaying the algorithms live to advocate for algorithmic transparency in response to the trend of hiding algorithms from users. The fact that the code is projected during *HCCC* allows me to perform impromptu modifications to it to better communicate the main aspects of online tracking to the audience.

Choreographing Audience Participation

Throughout the performance, I invite the audience to engage with choreographic prompts that introduce aspects of online tracking, such as fingerprinting and profiling, through a series of physical enactments. As shown in Fig. 5.3, these prompts are overlaid on the webpage for the audience to read.

I designed the prompts following the given sequence:

- ‘STAND UP if your age: 25–34’;
- ‘STAND UP if your age: 35–44’;
- ‘STAND UP if your age: Unknown’;

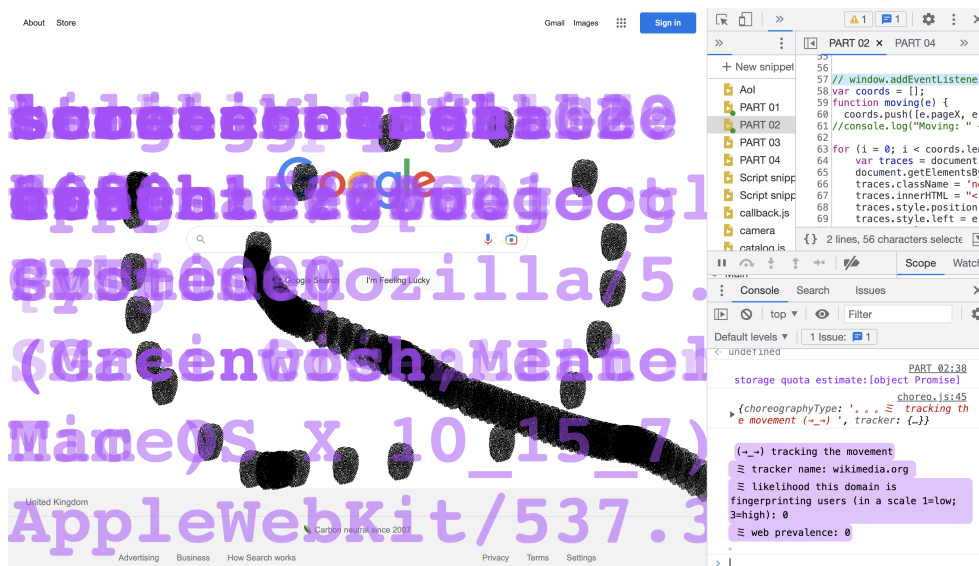


Figure 5.1: Screenshot detail of the interface with both user data fingerprint and a human fingerprint image trail overlaying the webpage (2024).

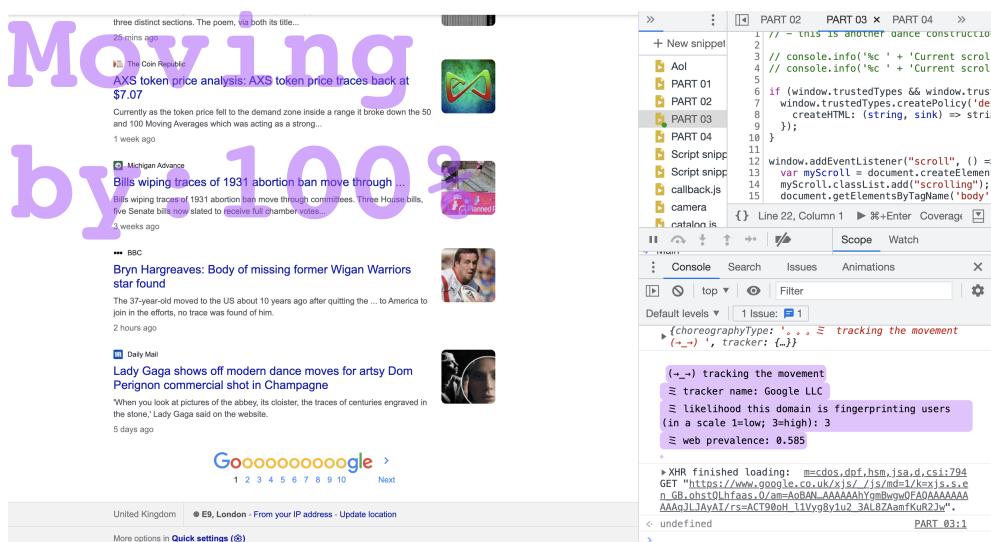


Figure 5.2: Screenshot displaying the current scroll percentage overlay on top of Google search results (2024).

- ‘STAND UP if you live in [city name]’;
- ‘STAND UP if you live in [city name] and purchased 1-5 items in the last 7 days’ ;
- ‘STAND UP if you live in [city name] and purchased at least 3 items in the last 5 days and spent more than 50 euros’;
- ‘Thank you for all the movements performed. Please return to your initial positions’.

For each performance, the prompts are adaptable to the audience setup. For example, if people are seated or if there is space to move, the type of movement might change from ‘stand up’ to ‘move to the left’ or ‘raise your hands’. The prompts also allow me to comment on people’s responses, for example, by concluding: ‘most likely someone sitting next to you is above 35

years old'. The latter emphasises the inferences that can be made from data extraction when employing online tracking algorithms.

I designed these prompts to choreograph the audience's participation using daily gestures. This choreographic approach is inspired by the method developed in the 1980s by Augusto Boal known as *Theatre of the Oppressed* (Teatro do Oprimido). Boal understood theatre as a rehearsal for everyday life. He did not see it as an end in itself, but as the beginning of a social transformation that supported the de-alienation of bodies and allowed the repetitiveness of daily tasks to be disrupted (Boal, 2019). Another inspiration for my choreographic approach is the American choreographer Yvonne Rainer, who observed individual pedestrians and crowds in the streets of New York City and transposed the movement observed into the theatre. This opened up new possibilities for performing mundane daily gestures (Wood, 2007).

These references (see also Section 2.2) shaped the way I designed choreographic prompts using movement vocabulary that favoured daily gestures that are performed both offline, such as standing and moving around, and online, such as clicking or scrolling. The goal was to physically engage the audience members in gaining an embodied understanding of online tracking technologies.

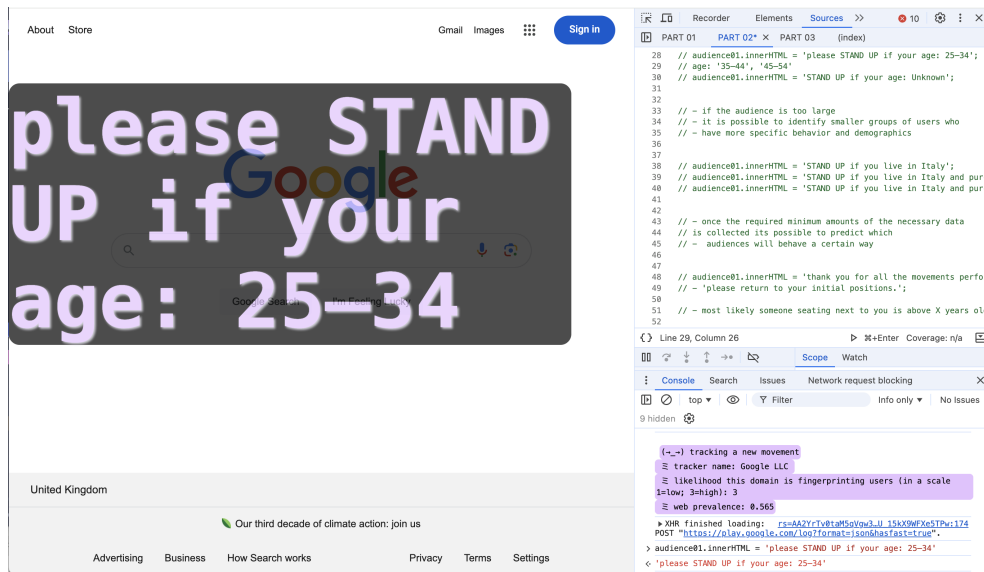


Figure 5.3: Screenshot of the choreographic prompts in large text on the screen for audience members to respond to (2024).

Dramaturgy

The last step in the making of *HCCC* was bringing all the elements together in a live performance. The binding theme of the performance is the dramaturgic approach, which integrates the tracking visualisation and sonification with audience participation and with the overall design of the browser. Dramaturgy is approached here in line with Hanna Slättne's view of it as a method of structuring an experience, a story, or a system (Slättne, 2022). I took Slättne's dramaturgical approach of 'foregrounding, accentuating and drawing attention' (Slättne, 2022, p. 515) to specific components, procedures, and

the sequencing of information in *HCCC* as described next.

The total duration of the performance is approximately 20 minutes. In the accompanying video ¹, the various parts that comprise the performance can be viewed. The performance starts with me walking on stage, making an analogy between fingerprinting and the performance event. I list descriptive data out loud, such as the current date, time, location, language, dimensions of the space, and its capacity. I go back to my laptop, and a projection of a browser window appears divided into two (as illustrated in Fig. 5.4): on the left-hand side showing the website (Google search engine) and on the right-hand side the web developer tools.

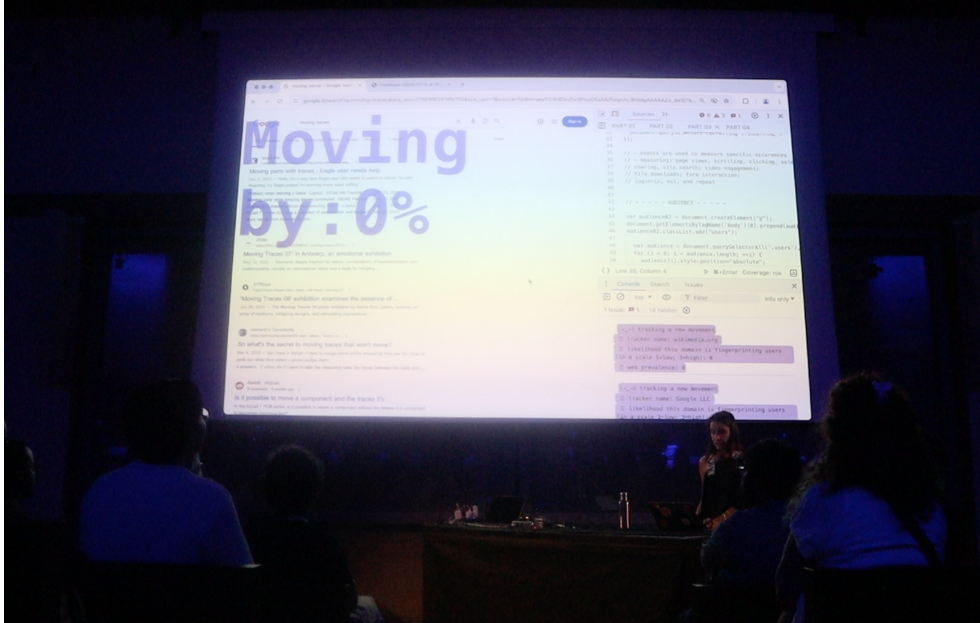


Figure 5.4: Video still of the performer on stage with a projection behind showing a split screen: on the left side the Google search engine results webpage with text overlay ‘Moving by 0%’ in colour pink and on the right side the web development tools (2024).

In the first part of the performance, I introduce fingerprinting. After calling a function that prints commonly used fingerprinting parameters, I read out loud each parameter to the point of being unable to keep up with the speed of text being shown as it accumulates and overlays on the screen until it is illegible. This highlights the scale of tracking and how it supersedes the human scale, as I am unable to keep up with the algorithm.

The second part of the performance focusses on audience participation: the audience is invited to move according to the on-screen prompts inspired by the web analytics data collection, as exemplified in Section 5.2.4.

The third part of the performance displays the traces left when interacting with the websites visited thus far. The sound of the metronome mapped to the trackers, as detailed in Section 5.2.4, plays as the tracking requests are triggered. I type ‘tracing movement’ into the search input field, to allude to how movement data is captured online. This search query leads to a list of Google search results on the left side of the screen, which vary depending on the

¹Performance’s video (5 minutes digest): <https://ualresearchonline.arts.ac.uk/id/eprint/24312/>

country of performance. I randomly click on 5-10 websites from the results, aiming to choose different categories, for example, news or e-commerce, for the audience to witness the contrast or similarities in the tracking requests triggered in each of them. Then, I scroll up the web console, on the right side of the screen, where the trackers have been listed throughout the performance, and read out loud a short selection to emphasise the amount and diversity of the trackers that accumulated up until that moment.

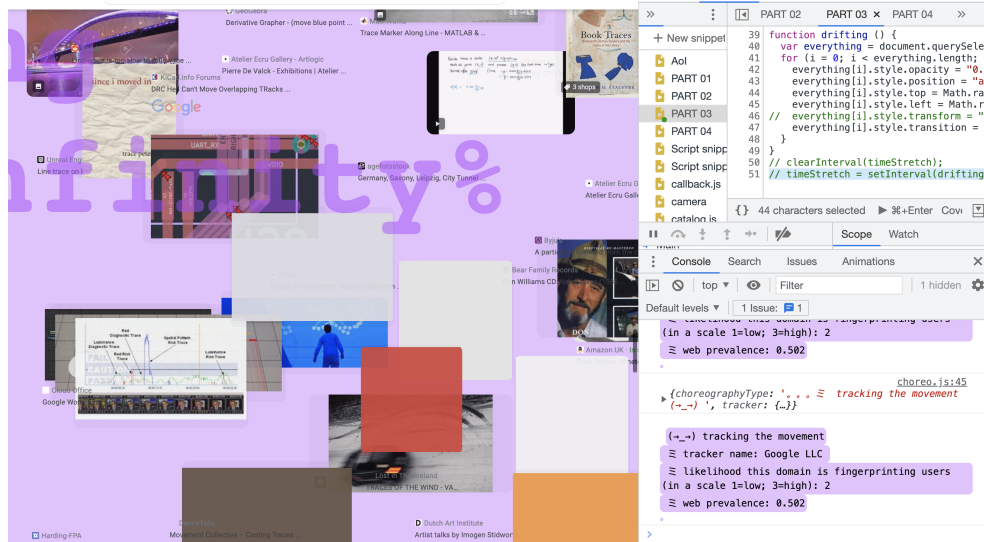


Figure 5.5: Screenshot of Google image search results showing images ‘off-grid’ overlaying each other after the performer manipulated code to change the style appearance (2024).

Next, I click on the image search results and call a function that displays the scrolling percentage, as in Fig. 5.2, which changes to ‘infinite’, as it operates as an infinite scroll. Further alterations to the visual composition are improvised in the moment, making the interface dynamically morph and its original display become almost unrecognisable (as shown in Fig. 5.5). The sound of the metronome mapped to the trackers intensifies as the tracking requests are triggered by more images loading, and their display is modified. The idea behind the intensification of the overlapping text elements, the chaotic morphing images, and the metronome sound effects is to give the audience a feeling of overwhelmingness that reflects the ‘cumulative’ aspect of tracking. This aspect speaks to the choreographic concept of accumulation developed by Trisha Brown (Rosenberg, 2012), introduced in Section 4.3.

In the final scene, I type commands to go back into the browser history. While each page loads, the tracking requests continue to trigger the metronome at different rhythms until I arrive back at the initial screen with the Google search landing page.

Overall, the dramaturgical choices of climaxing and calming down are geared towards progressively inviting the audience to feel overwhelmed by online tracking, to develop resistance to it, and imagine ways to move against it.

5.3 Performing *HCCC* and Probing Audience Members

5.3.1 Methods

Performance Setup and Audience Demographics

After an initial phase of design and production of the performance as described above, I presented the performance at three different events, the International Conference for Live Coding in The Netherlands in April 2023, HASTAC on Critical Making and Social Justice in the USA in June 2023, and xCoAx Conference on Computation, Communication, Aesthetics & X in Italy in July 2024.

Minor adjustments were made between performances to accommodate the feedback collected and to improve the experience of the audience. Changes between performances included presenting each tracking technique more clearly and making the visual display more legible.

Audience involvement has been crucial in understanding whether my objective of raising critical awareness has been met and in collecting feedback on the performance. After each performance, a questionnaire was provided for audience members to share their experiences (see Appendix A). I chose the questionnaire format rather than interviews, as it is more suitable for probing a larger number of people in all performances. A total of 43 responses were collected. The questionnaire included Likert scale questions, with seven options from ‘Strongly Disagree’ to ‘Strongly Agree’. The questions included:

- ‘The duration of the performance felt right’;
- ‘Before the performance, I had a good understanding of what online tracking algorithms are and how they work’;
- ‘After the performance, I had a good understanding of what online tracking algorithms are and how they work’;
- ‘The browser interface used in the performance clearly displayed what the algorithms were doing’;
- ‘The movement tasks at the start of the performance were useful in creating a parallel with online tracking’.

The questionnaire also included open-ended questions:

- ‘What do you see as the main connections or parallels between the performance’s choreographic ideas and online tracking algorithms?’;
- ‘What was your favourite part of the performance?’;
- ‘What could be improved? Feel free to add suggestions for future iterations’.

In the first performance, I collected 18 responses to the questionnaire, the respondents were between 24-63 years old, and half identified their gender

as male and the other half as female. In the second performance, a total of 8 people responded to the questionnaire, ranging in age from 26-45, 6 of whom identified as female and 1 as male. In the last performance, a total of 17 people responded to the questionnaire, ranging in age from 25-59, 56% of whom identified as male and 44% as female.

I opted to share the performance during three conferences on live coding, computational arts, and digital activism, which are communities of which I am a part. Although I might speculate that, in these contexts, attendees had a level of technological literacy, I did not specifically collect data on their expertise in online tracking. In fact, the responses to the questionnaires showed that their levels of literacy were varied and not specific to online tracking. This is evidenced in the Likert Scale results described in Section 5.3.2, which states that audience members increased their understanding of what online tracking was and how it works. In Section 5.4.3 I further discuss the demographics of my audiences and my aim to broaden them in future performances.

Data Collection and Analysis

The responses to the open-ended questions collected from the performance questionnaires were evaluated through a reflexive thematic analysis (Braun and Clarke, 2022). The thematic analysis process followed a six-phase structure of familiarisation, coding, theming, review, definition, and documentation (Braun and Clarke, 2022). These were not part of a linear trajectory but integrated a recursive process (Braun and Clarke, 2006) in which my co-supervisors (Prof. Rebecca Fiebrink and Prof. Sarah Fdili Alaoui) and I returned to revise the work done in the previous phases. For the initial phase of familiarisation, the data collected from research activities was printed out for note-making; for the next phases, a spreadsheet was used. Coding and analysis followed predominantly an inductive approach in which codes and themes were derived from the data. In addition, quantitative data analysis was employed, specifically a one-tailed Wilcoxon Test, which is a commonly used statistical method to analyse Likert-scale responses (Lazar et al., 2017).

Both qualitative and quantitative analyses aimed to capture a broad understanding of how audience members engaged with the performance and the connections they made between the choreographic approach and online tracking.

All audience members gave their consent to use their information for my research study, which was approved by the Research Ethics Committee of my academic institution. Audience members have been assigned unique IDs from A1 to A43 for anonymisation purposes.

5.3.2 Results

From the data analysis, three high-level themes were generated. The first focusses on how the performance revealed the prevalence of tracking algorithms online. Provides evidence of how the audience became more familiar with online tracking after attending the performance. The second theme concerns

how the choreographic aspect of the performance allowed audience members to critique data tracking online using their bodies. The third relates to how the performance allowed the audience to reflect on concepts related to power and lack of agency online. Next, I expand on the themes and provide quotes from audience members.

Revealing and Raising Awareness of Data Tracking Algorithms Online

As one of my goals for the performance was to impact the audience's understanding of online tracking, I used data from the audience questionnaire to conduct a preliminary investigation of whether this was successful. Specifically, I used two of the 7-point Likert scale questions from the post-performance questionnaire: 'Before the performance, I had a good understanding of what online tracking algorithms are and how they work' and 'After the performance, I had a good understanding of what online tracking algorithms are and how they work'.

Audience members' Likert-scale responses to these questions were compared. On average, participants' scores indicated a higher understanding of online tracking (Mdn = 6) after the performance than before (Mdn = 5). A one-tailed Wilcoxon Test indicated this improvement was statistically significant ($W = 23.5$, $z = -3.6143$, $p = .00015$), allowing us to reject the null hypothesis ('the performance did not increase people's understanding'). This indicates that the performance increased people's self-reported understanding of what online tracking algorithms are and how they work.

From my analysis of the responses to the open-ended questions, a significant number of audience members highlighted the performance's revelation of tracking algorithms. Its revealing character refers both to the literal revelation of the tracking through the customisation of the web extension and to the choreographic approach.

An audience member mentioned that the performance allowed them to see 'behind the browser' (A7), referring to the feeling of obfuscation of the algorithms that were brought to the 'surface' during the performance. Similarly, A32 highlights the code legibility and how the split screen layout 'was a resourceful way to show how the code impacted the website'.

The performer's intention to expose online tracking was reiterated by A17: 'the performance was very clear in its aim and really felt like it was making underlying web processes more exposed and explainable to an audience. The elements of humour and playfulness in engaging the audience were very useful in creating a dynamic performance about this topic'.

Audience members drew connections and even reappropriated the language of 'movement' and 'traces' in relation to the tracking of data as experienced during the performance. A36 referred to the realisation that 'our traces are recorded as we navigate the internet'. In a similar vein, A15 mentioned: 'I see that there is a connection between the ability to express user tracking and patterns obtained from the web through movement in a visual way. During the performance, I felt that this connection was further emphasised by the use

of JavaScript commands to manipulate web components live, which highlights the relationship between choreography and web interface design’.

Finally, A16 highlighted the element of ‘liveness of tracking processes’ in the performance as an antithesis to their daily experience online in which data tracking is obfuscated. Live coding as a format already focused on the presentation of algorithms in real-time was found to fit well with the aim of revealing tracking live, as it happens, to an audience.

Engaging Bodies in Critically Reflecting on Online Tracking

The performance engaged audience members in reflecting and critiquing online tracking algorithms through an embodied and choreographic approach. Many audience members provided comments in response to open-ended questions about their embodied experience of online tracking during the performance.

In contrast to online tracking, which is often abstract and hidden from users, audience members found that the performance opened a space for it to be felt and for a connection to be established between digital and physical spaces. For example, A17 highlights the role of choreographic prompts and physical engagement during the performance to make tangible an abstract concept like online targeting: ‘the parallel between creating segregation based on demographics like age and buying history was clear through its physicality in the audience participation’. A43 emphasised the embodied nature of the performance and how it helped to better understand tracking: ‘I thought the standing up part was very illustrative (of) how tracking works’. Similarly, A33 referred to the embodied aspect of growing awareness: ‘I was under the impression that it was a performance of movement and almost like a body awareness or somatic exercise but for our screen selves’.

The participants found that the choreographic exercises in the performance revealed how the online tracking strategies worked. A42 reflected on how the choreographic prompt in the performance is a metaphor for how online tracking conditions people’s behaviours online. They said: ‘your storytelling choreographed not only our behaviours (e.g. standing up), like a configuration we are meant to comply with, but you also guided the audience with your narrative, in the direction of your ultimate message. Similarly, these algorithms use our information as a means to an end, conditioning our online experience and, perhaps, our futures’. A17 also drew parallels between choreography and online tracking processes and strategies: ‘the manipulation and the dancing elements of the webpage also helped metaphorically outline the tracking processes and decomposed the web into moving and traceable parts’.

Participants reflected on the value of experiencing the traces that are left online and that were made visible by the performance. Participant A10 highlighted that the performance helped ‘situating the body within the technology - our actions online leave traces, as in life’. In a similar vein, A26: ‘I enjoyed the parallel between physical and digital space and the way we leave our marks on both. The logic we use to move through space is also present on the web’. This means that the performance brought bodies to the centre of the experience, acting as a common denominator across digital and physical spaces. It

linked experiences commonly felt separate from each other; for example, being in a specific physical location influences the content we see online.

A8 mentioned that the choreographic approach to online tracking led them to reflect on their “everyday ‘prosumer’ choreographies”. They reflected on how they, as users, act as both consumers and producers of data, through daily actions and gestures performed online, which feed into the algorithmic systems in place. This aspect relates to the next theme, which focuses on the conditions within which users’ movements online operate, particularly in relation to users’ agency or lack thereof.

Online Power, Agency and Lack Thereof

One of the themes generated was the lack of agency regarding online tracking. Some participants found that the choreographic prompts in the performance led them to reflect on the concept of agency and how online services take control over personal data, not always with consent. These audience members provided comments on this matter, in the words of A11: ‘by coming to a performance, we as audience members inadvertently put ourselves in the position of giving power to you as presenter: when you asked us questions and asked us to (I can’t remember) put our hands up then, we all went along with it. In everyday use of a browser, we are similarly giving away our power to advertisers and other online actors, without realising it’.

The order of the choreographic prompts purposefully plays with power dynamics, for example, by first asking audience members to reveal aspects of their personal data and only at the end providing the chance to opt-out. A10 mentions that as a memorable moment: “The realisation that we do not have to supply data e.g. ‘age unknown’ was the last category after asking audience their age. This showed me how ready we are to give our data if asked”.

Due to the live nature of the performance, audience members witness how tracking is prevalent on various popular websites and how powerless one feels. A22 emphasises this: ‘the performance engaged us, the audience, in a kind of process of tracking and making meaning of the performer’s digital and physical movements and actions, which was an eerie echo of how companies track us. I felt odd but fascinated being a voyeur’.

Thus, the performance led participants to reflect on the powerlessness and the insidious lack of agency that online spaces impose on their users.

5.4 Discussion

In this chapter, I illustrate how I designed a choreographic live-coding performance *HCCC* to reveal data-tracking algorithms in web environments. My analyses of the audiences’ responses to *HCCC* (described in Section 5.3.2) showed that the performance supported them to: (1) increase awareness of online data tracking; (2) critique online data tracking through choreography and embodiment; and (3) reflect on concepts related to power and lack of agency online.

This work contributes insights to the live coding and HCI communities by bridging the practices of live coding with choreography and grounded them in empirical evidence. In the following sections, reflections, takeaways, and possible directions for future work are presented.

5.4.1 Exposing and Embodying Data Tracking as New Approaches to Live-Coding

I contribute a new approach to live coding that supports audience members in gaining awareness of online tracking by exposing these mainstream algorithms and by using choreography and audience participation.

Exposing Mainstream Algorithms

While live coding traditionally exposes the algorithms that performers manipulate, these tend to be within custom-made programs that the performers develop and use, but may not be familiar to audience members (see Section 2.3.4). Additionally, the performances rarely explicitly point to the impact of the algorithms they display. While a critique of algorithmic opacity and Big Tech is implicit in the foundations of live coding — live coding’s first principle is algorithmic transparency (see Section 2.3.3) — most performances focus on audiovisual composition or other forms of collaborative work. It is uncommon for live coders to reappropriate familiar mainstream tools and systems, and even less common for them to reveal their impact on people. The specificity of my approach in *HCCC* was to manipulate mainstream algorithms and to display these manipulations in front of audience members to open a space for them to critique them and reflect on their impact on their lives. The findings show that my approach was effective in critically engaging the audience members in reflecting on the presence of data extractivist technologies. My findings showed, for example, that exposing mainstream algorithms helped participants question how their actions online are used as data to profile them.

Thus, even though the underlying discourse in the live-coding community is political, supportive of open-source technologies, and regularly contributes to those efforts, the performances are rarely explicitly political. Instead, most live-coding performances are aesthetic audio-visual experiences. *HCCC* distinguishes itself from these by providing an experience that focuses on the exposure and critique of data extractivist technologies, thus extending the scope of the current literature on live-coding performances. This work contributes to the live-coding community by illustrating an approach that live coders can appropriate in their work to explicitly display the algorithms that they manipulate to foster critique and advocate for activism among audience members.

Choreography and Audience Participation for Increased Digital Awareness

My approach focuses on involving audience members in performing physical tasks. Instead of presenting data tracking as a distant phenomenon (confined

to a screen), I bring it closer to people’s embodied experiences. This allows them to make connections between what they witness on the screen and their own bodies. As reported in Section 5.3.2 I weave together both physical and digital aspects of tracking, and audience members perceived it as I intended.

These findings connect to previous live-coding performances that involve audience members in various aspects of the performances. One example is *CrowdPatching* (Beverley and Ogborn, 2017), a system for audience participation that allows the audience to change the performance’s visual and audio parameters in real-time by connecting to a web interface through their mobile phones. Although this participatory approach focused on interaction with the live-coding systems in place, the audience’s participation did not extend to physical tasks. On the other hand, live-coding pieces such as *Codes for a Dance* (Sicchio and McLean, 2023), *CO/DA* (Françoise et al., 2022) and *MosAick* (Wilson et al., 2023) focused on designing systems to choreograph and facilitate physical engagement of the performers themselves.

HCCC combined both approaches, using live coding to choreograph audiences and choreographing audiences to engage with the live-coding piece. My embodied and choreographic approach helped the audience members understand how tracking works and critique it. As I demonstrated, live-coders can explore new forms of prompting audience members and break the ‘fourth wall’ separating performers from their audience. I showed that including physical and embodied participation of the audience offers a more direct connection between the audience and the topic of the performance. Thus, my work contributes to live coding by demonstrating the effectiveness of embodied and participatory approaches to foster the audience’s interest and grow their algorithmic awareness.

5.4.2 Exposing and Embodying Data Tracking as New Approaches to HCI

HCCC contributes to HCI by demonstrating a live setting that critically engages audience members with tracking algorithms by both witnessing them on stage and embodying them.

Benefits of ‘Liveness’ for HCI

The results show the potential of live coding in exposing the prevalence of social control in algorithms and inviting audience members to reflect on them. Foucault developed the concept of social control, which refers to rules and restrictions that shape, supervise, and regulate the behaviour of individuals in societies (Foucault, 2020). I believe that the first stage for resisting the mechanisms of social control is to expose them. My piece illustrates how I used the liveness of live coding to reveal the mechanisms of online tracking on stage to make explicit how they shape and control users, echoing Li et al.’s argument (Li et al., 2023). *HCCC* displayed the daily interactions people have with data tracking and, by doing so, opened a space to imagine how other systems might operate and how users can subvert their usual ways of working.

Although audience members were not explicitly asked to reflect on forms of countering online tracking during the performance, some of the actions taken by the performer were perceived as opposing or resisting tracking. In the findings, I described how A4 made a parallel between the choreographic approach proposed in *HCCC* and what they perceived as forms of countering ‘tracking requests and measurements’. Another audience member, A15, understood the live coding in the browser as ‘JavaScript hacking’. The concept of hacking is inherently subversive and attempts to disrupt existing systems. This relates to my intent to open pathways for reflection, critique, and ultimately resistance to extractive algorithms such as online tracking. Thus, my work contributes to HCI by demonstrating the effectiveness of exposing the mechanisms of tracking algorithms to foster awareness and critical engagement in the audience.

Benefits of Embodied Participation for HCI

Additionally, my piece illustrates how I utilised audience participation and embodiment as an effective means to involve people in critically reflecting on data tracking. The results show that embodiment and choreography contributed to engaging the audience in reflecting more intimately and viscerally on the algorithms’ impacts. The audience went beyond witnessing the effects of online tracking: *HCCC* created a shared experience that involved the audience physically-individually and collectively. Instead of tracking being an external phenomenon, including embodiment and audience participation in my approach emphasised the entanglement between people’s actions and data extractivist technologies that choreograph them online. Similar performances developed in HCI have used audience participation to foster critical reflection of engagement-based algorithms (Backhouse et al., 2023) or peoples’ dependence on mobile technologies (Alaoui and Matos, 2021). I contribute to this line of work by advocating for audience participation alongside clear demonstrations of the mechanisms behind the algorithms critiqued in the performances. My approach aims to reveal how these algorithms shape users while enabling a more direct and embodied form of critical engagement with them.

Building a performance that is physically engaging while being critical, political, and entertaining at the same time is a challenging endeavour. As pointed out by Skirpan et al., ‘even if we know fiction and enactments have the potential for reflection and inquiry by participants, it is not easy or obvious how these efforts could be formatted for broad accessibility. That is, we consider the balance between engagement and entertainment, detailed technical content and artistic simplification as well as audience interaction and narrative structure’ (Skirpan et al., 2018, p. 2). My piece contributes to these efforts by detailing how I designed, performed, and analysed audience responses to a performance that both exposes online tracking and engages people in enacting it.

My dual approach to ‘liveness’ from live coding (such as manipulating and displaying) the algorithms on stage, combined with audience participation through the enactment of these algorithms, contributes to HCI with two

complementary entry points to allow people to grow their understanding and critique of data tracking. I see potential for my dual approach to be appropriated by HCI researchers, outside the confines of theatres, to grow awareness of a large number of malicious algorithmic practices and reach larger audiences.

5.4.3 Limitations and Future Work

My approach to the *HCCC* performance certainly presents limitations. I see these limitations as opening opportunities for future work.

As mentioned in Section 5.3.1, audience members were mainly drawn from people who attend live coding, computational arts and science, and humanities conferences. This might not reflect how a general audience might perceive the performance. I am interested in further exploring the impact of the performance in events and venues that host a broad audience, one less familiar with online technologies. For that, the performance design might need to be adapted, for example, by adding a more detailed introduction to online tracking at the start of the performance. Or by drawing attention to each aspect of tracking through more explicit connections between the data collected and the visual and sound clues on the screen. Performing the piece in a broader context would be possible, since my design emphasises portability (the technology operates within a web browser that can be adapted to a variety of contexts). This would allow *HCCC* to be presented, for example, in public spaces or streamed online to reach larger audiences. I see the potential of my approach to live outside the confines of theatres or conference venues to impact the general public. Chapter 8 details a final project – a publicly accessible series of choreographic scores — designed to broaden access to research developed through *HCCC* and overcome the limitations of the performance format.

Moreover, *HCCC* focused on exposing online tracking algorithms and prompting audience members to embody such algorithms so they could relate more meaningfully and deeply to them. In the current version of *HCCC*, I do not feed the performance real-time tracking system with personal data from the audience participants. Further development of the piece could include other forms of personal data capture. This idea comes closer to the project *Quantified Self* (Skirpan et al., 2018), which asked audience members to provide their social data to shape a personalised experience. I am interested in exploring how my embodied approach can be combined with other forms of data capture from the audience, integrating, for example, sensor data or mobile interactions. Capturing various personal data from the audience exposes them to different forms of data tracking in daily life, which are often obfuscated. Growing awareness of these would allow audiences to expand on the critique of surveillance capitalism (Zuboff, 2015) and the prevalence of data extractivism in our societies (Evgeny, 2017; Mejias and Couldry, 2024).

Finally, my strategy in problematising data extraction through participation and a sense of embodied engagement supports sensemaking and critical reflection, which drive change. The live algorithmic aspect of the performance combined a ‘real scenario’ (that of data tracking) with an imaginative one (that of counter-choreographies), opening space for new and emerging

emancipation strategies. Although the concept of counter-choreographies is not explicitly addressed during the performance, it is an invitation to take the next step in resisting or countering online tracking. The work described next first explores the engagement of participants in generating ideas for countering extractivist technologies (Chapter 6) and then explores how this engagement leads to user behavioural change (Chapter 7).

5.5 Conclusion

HCCC is a live-coding performance that reveals the algorithms that track users on web interfaces. The findings, derived from the analysis of the audience's responses to the performance, demonstrate how the performance revealed and increased the audience's understanding of the prevalence of online tracking algorithms. In addition, the embodied and choreographic aspects of the performance allowed audience members to critique data tracking and reflect on power issues and the lack of agency online.

My contribution is twofold: (1) I present a novel approach to live coding that combines choreography with online tracking, and (2) I share insights on the effectiveness of performance in engaging audiences to reflect on and critique data tracking. My contribution benefits the live-coding community, as my piece illustrates the impact of exposing mainstream algorithms and the use of choreography and audience participation to increase their awareness of these algorithms. It also benefits the HCI research community, as my approach shows the potential of live coding and the benefit of using choreography and audience participation to expose the prevalence of data tracking and involve audiences physically in reflecting on these issues.

The insights from this research contribute to both live coding and HCI by exploring embodied and algorithmic approaches that can empower audiences to critically engage with online tracking and imagine alternative futures.

Chapter 6

Workshop Series

6.1 Introduction

The *Human-Computer Counter-Choreographies* (HCCC) workshop uses choreographic approaches to connect data tracking with daily gestures that people perform both offline, such as standing and moving around, and online, such as clicking or scrolling. The work described here adds to the previous work in Chapter 5 by inviting participants to generate ideas to counter it, introduced as ‘counter-choreographies’.

Thus, the goal of the workshop was to enhance participants’ awareness of online tracking, which could inform strategies to reclaim their agency over their data and advocate for overall algorithmic transparency. To do so, I posed the following research questions:

- RQ1: How can I design a workshop that allows people to gain awareness of data-tracking algorithms through embodiment and choreography?
- RQ2: How does the workshop support participants in critically reflecting on online tracking and generate ideas to counter it?

The workshop introduced participants to online tracking algorithms through the lens of choreography. The participants engaged in a series of exercises that included mapping daily tech usage, performing embodied interpretations of user metrics, and experiencing the visualisation and sonification of tracking requests from a custom version of the DuckDuckGo browser extension (see Chapter 4).

The workshop activities informed a discussion on online tracking and an exploration of possibilities for counteracting such data extractivist technologies. At the end of the workshop, participants responded to an open-ended questionnaire to assess the impact of the workshop’s proposed methodologies on enhancing awareness and engendering novel perspectives on online tracking algorithms ¹.

¹In addition to participants’ involvement in the workshop, some provided minor contributions, such as proofreading or making suggestions to clarify or enrich the content of the text in this chapter, which was originally published as a paper. In line with the collaborative nature of the HCCC workshop, my supervisory team and I agreed on the value of involving participants beyond the workshop so that the writing process incorporated and was reflective of their experiences.

The *HCCC* workshop had a significant impact on participants, as evidenced by the results. Specifically, it allowed for growing awareness around the lack of agency regarding data harvesting and its use by digital services, generating ideas for reclaiming agency over personal data tracking, as well as utilising embodiment to support critical reflection on online tracking.

My contribution in this chapter is two-fold: (1) I present a new workshop design for raising critical awareness of data-tracking through an embodied choreographic approach; (2) I share empirical insights on how my approach engages people in critical examination of online tracking in their day-to-day and inspires forms of countering extractive algorithmic systems.

6.2 Workshop Design Process

6.2.1 Criticality

In line with Critical Design research (see Section 3.2.2), I designed workshop activities that invite participants to analyse their digital ecosystem; interrogate the algorithmic and data practices of the services they use; and engage critically in the discussion of counter-choreographies for these ecosystems.

6.2.2 Embodied Sense-Making

The workshop was designed as a collaborative and embodied space, with the aim of facilitating an exchange of perspectives and promoting collective sense-making on the topic of online tracking. I implemented choreographic techniques to facilitate individual and collective bodily experiences. These included prompts for participants to respond through physical acts such as standing up, walking, or making gestures. My goal for these prompts was to encourage participants to enact and embody invisible and abstract concepts related to online tracking.

6.2.3 Designing the Workshop Activities

In line with my RQs, the workshop aimed to inspire participants to generate ideas to counter current opaque and extractive algorithmic systems, here seen as ‘choreographies’. The workshop was divided into two main parts: (1) Identifying and Analysing (choreographies) and (2) Problematizing and Countering (choreographies).

The first part focused on introducing online tracking and mapping its presence in daily life, while the second part guided participants towards creating counter-choreographies or strategies against the prevalence of tracking. The activities for these two parts are summarised in Table 6.1. The workshop activities were structured sequentially, progressively guiding participants towards generating counter-choreographies. In line with Critical Design practices (Dunne, 2008), each activity was designed to encourage reflection and critical thinking on different aspects of data tracking, as described next. Furthermore, in line with embodied sense-making, my background in dance and

choreography (see Section 1.1) allowed me to use my ‘somatic connoisseurship’ (Hook, 2018) to facilitate embodied exercises during the workshop.

The workshop’s design followed an iterative process. I first facilitated two pilot iterations before coming to the final third version. The pilot workshops consisted of a series of activities that were iterated or discarded.

Both pilot iterations of the workshop took place in the UK, the first in Bristol at Control Shift Festival in April 2023 and the second in Leeds at Space2 in May 2023. A total of 17 people attended the first iteration of the workshop. Most of the attendees had a background in the arts (including dance and performance) and/or computer programming, with ages ranging from 24 to 52 years. One person identified as nonbinary and of the remaining participants, half identified as male and half as female. In the second workshop iteration, there were 10 participants. They consisted of artists or retired people doing art as a hobby; other backgrounds included reflexology, administrative work, and housekeeping. The age range was between 19 and 86 years and the majority identified as female. Similar forms of data collection and analysis as described in Section 6.3.3 were conducted in the pilot studies. They served to inform the iterative development of the workshop. In both pilot workshops, the recruitment was managed by the venue organisers.

Part 1: Identifying and Analysing (choreographies)

The activities of the first part of the workshop were based on the two previous pilot iterations as described in Fig. 6.1.

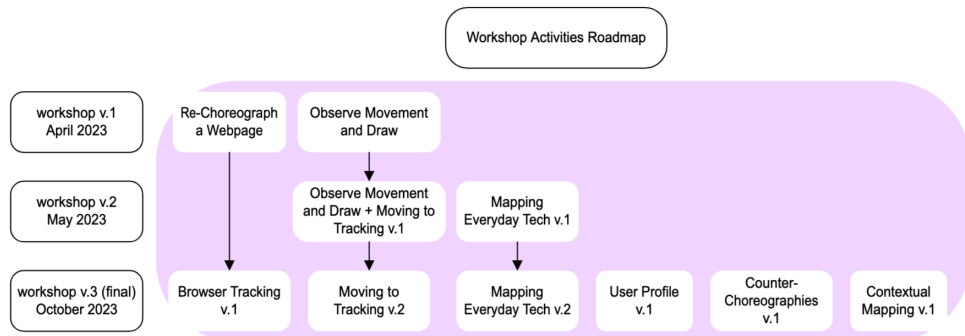


Figure 6.1: Schema displaying the *HCCC* workshop activities roadmap (2025).

The first two activities introduced participants to the main topics of online tracking and the choreographic approach that guided the research. The second half directs participants to reflect on their digital ecosystems and how they are implicated in online tracking, paving the path for the making of counter-choreographies.

Browser Tracking Demo: In the first iteration of the workshop, participants were introduced to their browsers’ web developer tools to interact in real-time with online environments and their content. They were then invited to ‘re-choreograph’ a webpage of their choice by making changes to its style and content. This exercise was left out in future iterations as it requires prior

Part 1: Identifying and Analysing (choreographies)

<i>Activity</i>		<i>Length</i>	<i>Description</i>
Browser Demo	Tracking	10 min	Visualisation and sonification of tracking requests from a custom version of Duck Duck Go browser extension.
Moving to Tracking		20 min	Collective physical enactment of choreographic prompts inspired by user analytics data collection.
Mapping Tech	Everyday	10 min	Individually, listing the digital services used daily and reflecting on the data these services gather.
User Profile		20 min	In groups, making a profile representative of the group based on a common digital service.

Part 2: Problematizing and Countering (choreographies)

<i>Activity</i>		<i>Length</i>	<i>Description</i>
Counter-choreographies		30 min	In groups, generating ideas on resisting or counteracting online tracking in the common digital service by combining movement vocabulary and user metrics.
Contextual Mapping		20 min	In groups, analysing counter-choreographies in relation to other sectors, such as the economy, industry, policy or the environment.

Table 6.1: Overview of workshop activities.

'Walk **backwards** if you live in _____ and purchased 1-5 items in the last 7 days';

ADD to the prompt above.

REMOVE from the prompt above.

SCALE the prompt above.

SUBSTITUTE the prompt above.

Figure 6.2: Example of a choreographic prompt presented to workshop participants during the Moving to Tracking exercise (2023).

technical knowledge in web programming, which participants in that specific event had, but not in future workshop iterations.

Instead, to introduce online tracking algorithms, I gave a performative lecture to illustrate the concepts of tracking and user analytics. I used the browser extension tool for visualisation and sonification of tracking requests introduced in Chapter 4. This tool consists of a custom version of the open-source DuckDuckGo privacy extension (DuckDuckGo, 2018) that maps each tracking request to audio and visual feedback using JavaScript. For each tracker request, the sound of a single metronome click plays and the background colour of the page flashes pink (see Chapter 4 for further documentation). Participants gained an understanding of online tracking algorithms through an immersive audio-visual experience in a web browser.

Moving to Tracking: In both pilot iterations, I included an exercise that consisted of observing people's movements and drawing them on paper. Although this exercise proved useful for breaking the ice and warming up the participants, it was removed in the final iteration because its connection to the concept of online tracking felt too abstract.

For the second and last iteration of the workshop, I designed a 'Moving to Tracking' activity (the second exercise in Table 6.1), which engaged participants in physical enactments using daily gestures to gain an embodied understanding of online tracking technologies. In this activity, participants engaged in specific movements in response to the prompts I facilitated, inspired by the collection of user analytics data. An example of one of these choreographic prompts is: 'Walk backwards if you live in this city and purchased 1-5 items in the last 7 days' (see Fig. 6.2). In the last workshop, the prompts were projected onto a screen for the participants to follow the exercise easily. The participants were then invited to voice out loud modifications, for example, by 'adding', 'removing' or 'substituting' parts of the prompt. This vocabulary was reused in the second part of the workshop as described in Section 6.2.3.

These choreographic prompts were designed to instruct participants to use

familiar daily gestures and physical actions to enact data-tracking algorithms, for example, by connecting the physical activity of ‘walking’ with personal information such as ‘location’ or purchase history. The prompts have been iteratively designed and tested throughout the workshops and were inspired by Augusto Boal who developed the Theatre of the Oppressed in the 1980’s and postmodern choreographer Yvonne Rainer (see Section 2.2). Both artists took inspiration from the movements of pedestrians and crowds. This opened up new performative possibilities and aimed to inspire social transformations – specifically, through the de-alienation of bodies and minds. They achieved this by bringing attention to and disrupting the repetitiveness of daily tasks (Boal, 2019; Wood, 2007). Similarly, the *HCCC* workshop interweaved movement and choreography with concepts related to daily online tracking.

List the online services you use day-to-day
 E.g.: social media • news • email • maps or transit apps • shopping • banking apps • search engines • government websites...

What data is being collected? What information is being asked from you?
 E.g.: date of birth • gender • location • phone number • audio data • photos • clothing size • sexual orientation • religious or philosophical beliefs • trade union membership • salary info ...

**MAPPING
EVERYDAY
TECH**

Figure 6.3: Image of the template for the ‘mapping everyday tech’. Participants fill in the names of online services they use (blue boxes on the left), followed by the corresponding data they think is extracted by the same service (pink boxes on the right) (2023).

Mapping Everyday Tech: The second and third iterations of the workshop included this exercise, developed with a critical approach (see Section 6.2.1) to prompt participants to reflect on the data gathered by the digital services. To do so, participants were asked to write down the platforms and digital services they use daily for their work or in their personal lives. These include, for example, social networks, news, maps, shopping, or online banking apps. For each of these, participants were asked to write down data that they believed were collected, such as date of birth, gender, location, and audio or photo files, among others. The template for ‘Mapping Everyday Tech’ (Fig. 6.3), and consecutive A3 templates were specifically designed for the last version of the workshop for the participants to complete their tasks.

They were also provided with a set of grey cards (see Fig. 6.5) with concepts associated with user metrics, commonly used by online tracking and web analytics algorithms:

- device information: ‘user’s age’, ‘user’s gender’, ‘user’s device’, ‘user’s screen resolution’, ‘language preference’;
- user behaviour: ‘clicks’, ‘scroll percentage’, ‘idle time’, ‘browser history’, ‘engagement time’, ‘location’, ‘duration visiting a webpage’, ‘search queries’;
- other common user categories: ‘active user’ and ‘predictive audiences’.

They were also provided with small blank cards to create their own vocabulary. The participants were then asked to pair the elements of movement and user data vocabulary to generate ideas to resist and counteract online tracking on the service chosen in Section 6.2.3.

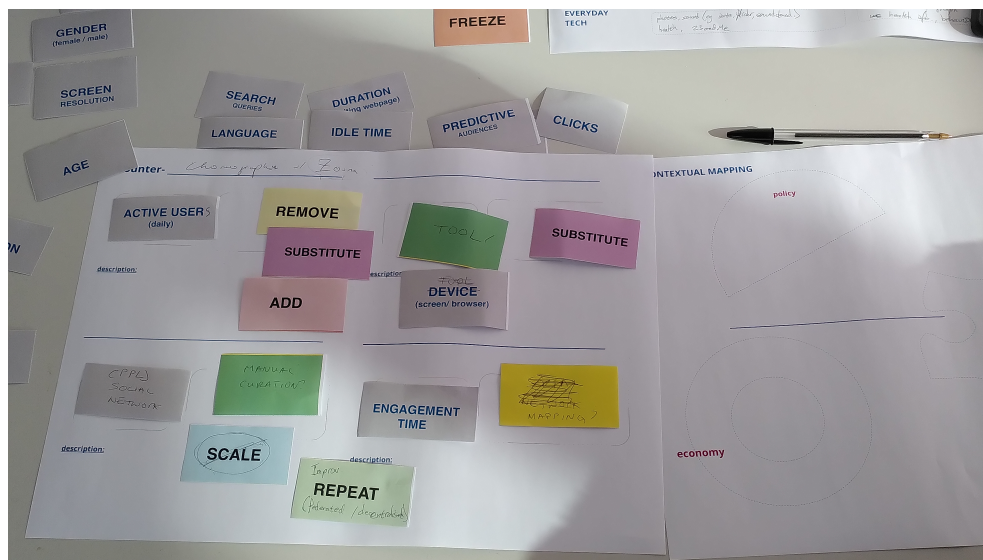


Figure 6.5: Examples of the workshop card printouts used in the ‘Counter-Choreographies’ exercise (2023).

Contextual Mapping: Finally, for the ‘Contextual Mapping’ activity (Fig. 6.7), the group analysed their counter-choreography in relation to other sectors, specifically the tech industry, economy, policy, and the environment. This activity invited groups to critically reflect on how their ideas for disrupting tracked metrics could effect change within industry, economy, policy, and the environment.

Group Discussion and Questionnaires

The workshop ended with a collective discussion where participants shared propositions and reflections on their counter-choreographies. Participants were also asked to fill out a questionnaire. It contained open-ended questions, including:

- ‘How have the embodied and choreographic approaches changed the way you think about online tracking (if at all)?’

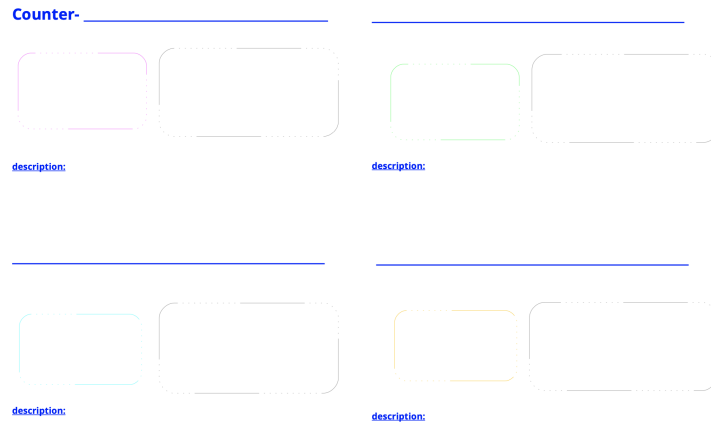


Figure 6.6: Image of the template for the ‘Counter-Choreographies’ exercise in which participants place the movement vocabulary (colourful cards in Fig. 6.5) and the user metrics (grey cards in Fig. 6.5) into the empty boxes above (2023).

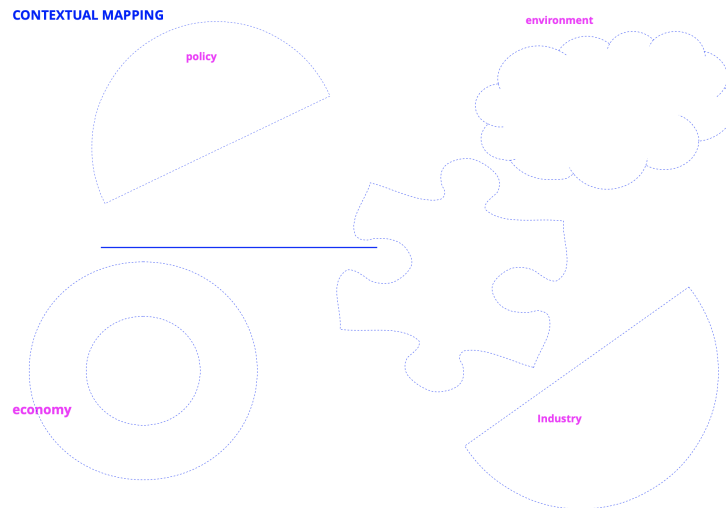


Figure 6.7: Image of the ‘Contextual Mapping’ template (2023).

- “What do you think is the strength of the concept of ‘counter-choreographies’?”
- “Where do you see the concept of ‘counter-choreographies’ being usefully applied?”
- ‘Are there any ideas, methods and/or processes that you will take with you that might be of interest to your professional practice?’

Finally, participants were asked if they faced any difficulties during the workshop and if they had any suggestions for improvement.

6.3 Deploying the Workshop in Practice

6.3.1 Workshop Organisation

The workshop ran twice in October 2023 in a room at my university and was scheduled from 11AM-3PM. Each time, I ran it with half of the recruited

participants to accommodate their availability and facilitate it more easily.

6.3.2 Participants

I recruited 16 participants. Eight attended the first workshop, and eight the second. During the two sessions, the participants were split into groups of two or three people. The resulting groups were assigned numbers from 1 to 6, and the corresponding group members were assigned unique IDs from P1 to P16 for anonymisation purposes.

Participants received an email invitation to participate in the workshop. Their contacts were gathered from my professional network. I chose to recruit participants with an interest in data-related algorithmic processes but who did not necessarily have experience with somatic practices or dance. My goal was to investigate the benefits that may arise from using a choreographic approach to critique data tracking.

In the post-workshop questionnaire (see Appendix A), participants provided information on their demographics. The participants' ages ranged between 29–53. Ten people identified as female, three as male, one as fluid in gender, one as non-binary, and one did not respond. Participants identified as tech-literate, with a high level of technological confidence, including around online tracking. Their professional backgrounds were spread across the fields of art, design, HCI, software development, and policy. They worked in industry and/or academia and their practice and/or research related to art and technology, data ethics, digital rights, and algorithmic justice. All participants in this and previous workshop iterations were fully briefed on the nature of the workshops and gave their consent to use their information for my research study. This study was also approved by the Research Ethics Committee of my academic institution.

6.3.3 Methods for Data Collection and Analysis

I collected data from the questionnaires and the audio recordings of group discussions. I also collected data from the workshop results in the form of photographs of the printouts and observation notes I took during the workshop. I analysed data from the audio transcripts, photographs, observation notes from the workshop and questionnaires using a reflexive thematic analysis (Braun and Clarke, 2022). The thematic analysis process followed a six-phase structure of familiarisation, coding, theming, reviewing, definition, and documentation (Braun and Clarke, 2022).

For the familiarisation phase, all the data were printed out, read, and annotated. The first coding phase was made by me using a spreadsheet. Using a different tab in the same document, codes were grouped into themes. Based on the initial codebook, one additional person, my co-supervisor (Prof. Sarah Fdili Alaoui), reviewed the coding and theming outcomes. This analysis aimed to capture a broad understanding of how our participants engaged in the workshop activities and the connections they made between the choreographic approach and the online tracking. Sarah and I then proceeded to refine the

Groups	Platform/ Topic	Description of Counter-Choreography
Group 1 (P2, P5 and P6)	Apple ID	‘Apple Garden’ is a proposal to shift the use of devices from individual to collective or communal use.
Group 2 (P1 and P4)	Google Maps	‘Get Lost’ is a proposal to randomize location data or remove it entirely.
Group 3 (P3, P7 and P16)	Zoom	Two proposals: first actively switching to alternative platforms; second scaling down the use of all such platforms.
Group 4 (P9, P10 and P12)	Instagram	‘Intentionality’ is a proposal for a feature that allows to set an intention and choose the granularity in which content appears on the platform.
Group 5 (P8, P11 and P14)	‘Time’	A proposal to disrupt capitalist notions of time embedded in algorithmic-driven platforms.
Group 6 (P13 and P15)	Reddit	A multiplicity of proposals to counter-choreographies to be acted upon the platform.

Table 6.2: Overview of the counter-choreographies created by participants in the workshop.

themes reported in Section 6.4.

6.4 Results

From the data analysis, three high-level themes were generated. The first focused on how my choreographic approach allows for growing awareness around the lack of agency regarding data harvesting and its use by digital platforms. The second theme highlighted the diversity of ideas that emerged to reclaim agency over personal data and tracking. The third theme concerned how embodiment and choreography supported critical reflection on online tracking. Below, I expand on the themes and provide quotes from participants evidenced by the counter-choreographies they created (see Table 6.2).

6.4.1 Reflection on the Lack of Agency Regarding Data Harvesting and its Use by Digital Platforms

The findings showed that the critical, embodied and choreographic approach described in Section 6.2 improved participants’ awareness of the lack of agency that they experience online. Participants reported that the critical approach underlying the design of the workshop allowed them to deepen their understanding of how their data is harvested and used by digital platforms. For example, in the responses to the questionnaire, P3 described how the sound ‘experience’ during the demo of the browser extension (see 6.2.3) was ‘very

powerful to solidify an understanding of how pervasive tracking is'. Each of the six groups focused on different aspects of the online platforms. However, they all reflected on their agency within these platforms and the lack thereof.

Group 1 referred to feeling 'locked' in a digital ecosystem when presenting their counter-choreography during the workshop. They focused on Apple products, which facilitated data access and synchronisation across devices through the Apple ID feature. Although they acknowledged the seamlessness of the service, they critiqued the fact that this 'unique portal' meant that a single company got a monopoly over their data.

Group 2 felt particularly concerned about the data used to build their profile on the Google Maps service and how it matched with other services to provide recommendations or to sell ads. They expressed concerns about data inferences, the opacity of the company's practices, and the inability to fully erase their data.

Group 3 examined Zoom, highlighting its role as a default platform for collaboration with some users who rely on it extensively throughout their workdays. They expressed concerns about the dependency on the platform for both personal and professional use and its implications regarding the data collected, such as voice and contact information. Their counter-choreography highlighted the dependence on corporate technology in the workplace and the lack of agency in choosing platforms in the work context.

Groups 4 and 5 reported a lack of control in the time spent interacting with digital devices. While Group 4 focused on Instagram and the content they feed it. Group 5 examined the contrast between how digital devices shape the experience of time versus individual and collective human temporal perceptions. They highlighted tensions between these experiences, critiquing the normative and politicised time-frames imposed by technological artefacts, especially online platforms.

Finally, Group 6 reflected on how interactions and content creation on Reddit can reveal private and intimate details. They noted that users of niche sub-Reddits might unknowingly share personally identifiable information, such as specific geographic locations.

These six examples show how the workshop activities, and specifically those that I designed for the first part of the workshop (Section 6.2.3), allowed participants to reflect on their lack of agency on a variety of platforms. Specifically, the activity of the user profile described in Section 6.2.3 allowed participants to collectively analyse the strategies that are deployed online to collect data on each particular platform on which they focused. Although their choices of technologies, platforms, and services were distinct, the critiques they voiced were similar in condemning the insidious yet opaque online tracking practices of these digital platforms.

6.4.2 Ideas for Reclaiming Agency over Personal Data and Tracking

As described in Section 6.2.3, in the second part of the workshop, participants were asked to generate ideas to counter tracking, referred to as counter-

choreographies. Each counter-choreography brought to the surface concerns shared among group members, along with proposals for actively tackling their concerns. For example, P10 mentioned: ‘it’s made me think about paths of disruption, about not accepting things just the way they are, a slight wake-up call for my digital laziness’. Although the groups used the same printouts of movement vocabulary and user data, the outcomes of the workshop have proven versatile. They illustrated different combinations of using the movement vocabulary and the user data to inspire a large range of counter-choreographies.

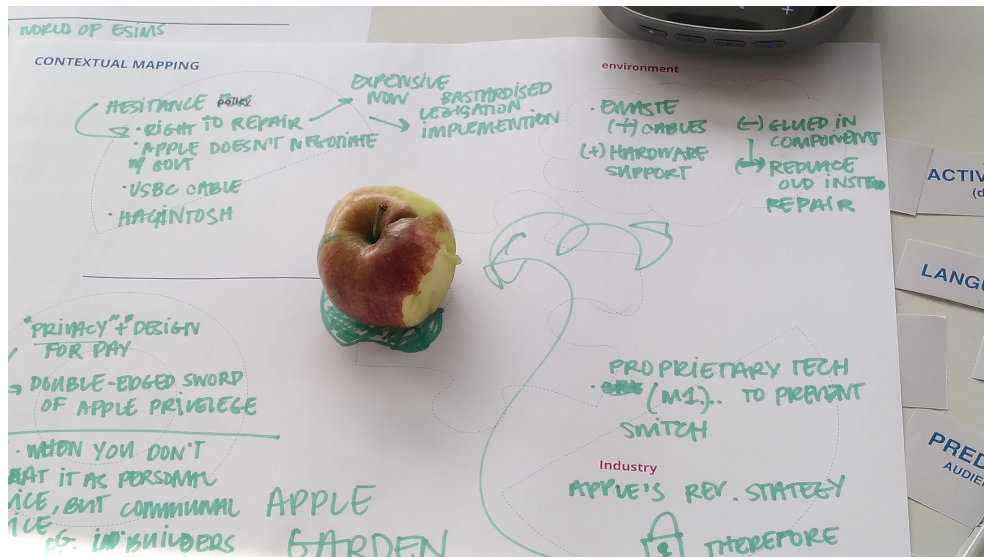


Figure 6.8: Contextual Mapping of the counter-choreography entitled ‘Apple Garden’, by Group 1 (2023).

Group 1 came up with the ‘Apple Garden’, presented in Fig. 6.8, a proposal to shift the use of devices from individual to collective or communal use. This idea came from the practice of sharing a single device amongst several users, as observed on construction sites in India, P6 noted. The group proposed a strategy centred on either ‘one to many’ or ‘many to one’ – a counter-choreography to confuse the ‘overseers’. By distributing a single Apple ID (a user account in Apple’s ecosystem) to multiple persons, or conversely, by a single user obtaining multiple Apple IDs, the company would have a harder time ‘knowing’ a unique user through their online behaviour. This counter-choreography favoured a collective approach concerning their digital ecosystem over an individualistic one.

‘Get Lost’ is a proposal from Group 2 that focused on Google Maps, to randomise location data or remove it entirely. Ultimately, this counter-choreography is an invitation to disentangle from location tracking, get lost, and explore new routes. A group member, P1, wrote in her questionnaire response that the choreographic approach supported her reflecting not only on ‘when to move but also when to stop moving’. In her reflection, she mentioned adopting the choreographic vocabulary of the workshop and understanding movement as both a physical activity and a political stance.

Group 3, who looked at the Zoom video conferencing platform, proposed a combination of two interventions. One required actively switching to other

platforms. The second entailed scaling down the use of all such platforms, for example, by restricting features such as video to voice only. This counter-choreography highlighted participants' dependence on corporate technology in the workplace and the lack of agency in choosing their work platforms.

Group 4 named their counter-choreography 'Intentionality'. They proposed a feature that would allow them to set an intention and choose which content appears on Instagram according to what they intend to consume. The goal of this counter-choreography was to regain control over content filtering in social media platforms.

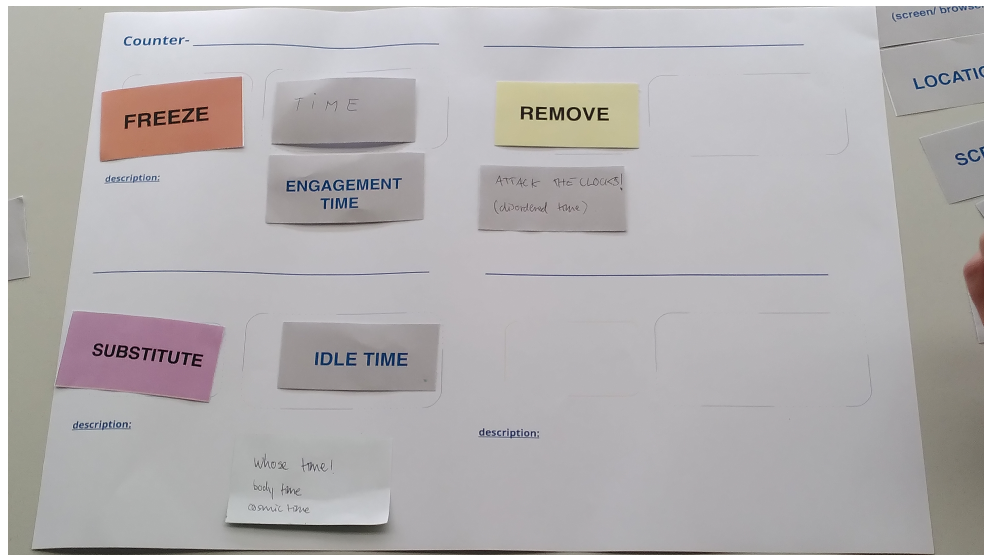


Figure 6.9: Work-in-progress counter-choreography focusing on the notion of time by Group 5 (2023).

Group 5 proposed a counter-choreography presented in Figure 6.9 for disrupting the capitalist notion of time. For example, they used the workshop movement vocabulary to 'freeze' time and consequently computational processes and data harvesting. Essentially, this counter-choreography disrupted the idea of 'user's time as money', forging new ways of valuing and experiencing time.

The last group, Group 6, created a multiplicity of counter-choreographies, as presented in Figure 6.10, which included the disruption of user data that is often collected by digital platforms. For example, they proposed to keep their screen up, freeze themselves, or be perpetually hyper-visible online while being offline.

Participants reported in the questionnaire that designing their own counter-choreographies allowed them to feel more empowered. In the words of P3: 'it feels empowering for me to think and physically act out ways to resist or block, which feels more active than opting out, for example'. Participants also reported that the counter-choreographies allowed them to imagine concrete ways of disrupting the tracking activities that they focused on. P13 said 'using a choreographic perspective highlights the deliberateness and curation of online tracking activities—it enumerates them and makes me consider entry points to how these specific actions can be disrupted rather than them only being passive and pervasive as they can often appear'. They described the counter-

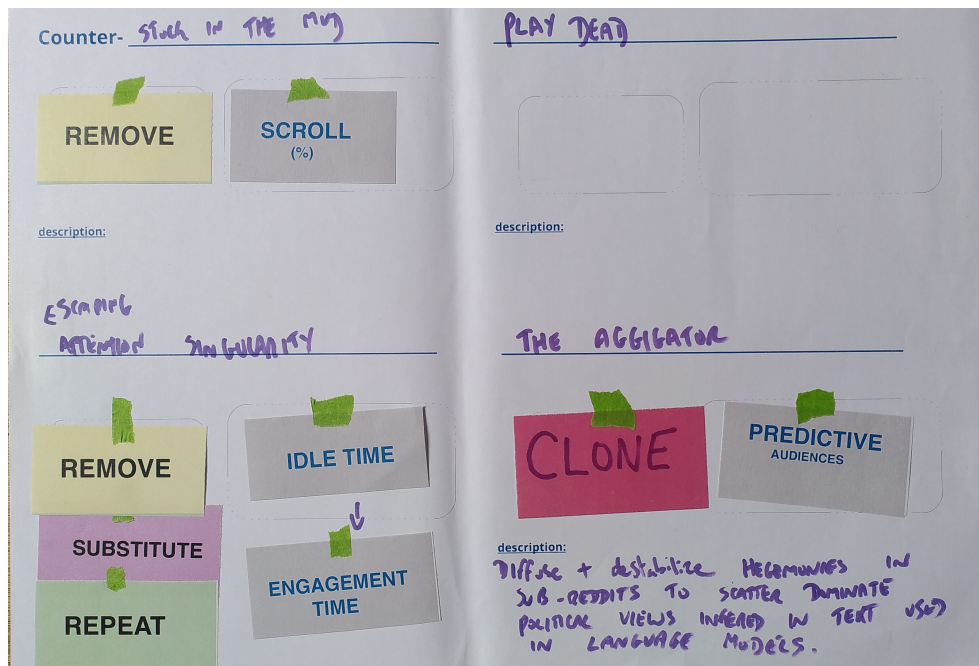


Figure 6.10: Counter-choreographies by Group 6 (2023).

choreographic method as a tangible and accessible approach that supports their reflection and action on forms of intervening: ‘it invites the imagining of concrete localised interventions into a field which is complex and may otherwise be impenetrable’ said P13. Similarly, P2 referred to the accessibility of the approach: ‘the creative and social language of dance that allows new ways of thinking about interventions in our digital lives and reclaiming our space-time’.

However, the participants mentioned that it can be challenging to imagine forms of resistance or disrupting systems that seem so embedded in daily life. In the discussion at the end of the workshop, Group 6 mentioned this difficulty and the tendency to think of strategies that already exist, for which there are, for example, existing plug-ins or single-use apps. The same group highlighted the importance of developing strategies that go beyond individual user agency and encourage collective action to achieve greater impact.

Overall, the workshop activities supported participants in imagining concrete, tangible ideas to counter online tracking algorithms. They saw the activities as a way to ‘free’ themselves from imposed rhythms, gestures, and constraints set by the different digital platforms.

6.4.3 Embodiment and Choreography for Engaging with a Critical Reflection on Online Tracking

The most recurring theme from the data collected in the discussion and questionnaires was the role that the embodied and choreographic approach played in engaging participants in critical reflection of online tracking.

Most of the participants explicitly mentioned the embodiment as a relevant part of their workshop experience in their questionnaire responses. Some highlighted the fact that the embodied and choreographic approach introduced in the ‘Moving to Tracking’ activity (Section 6.2.3) and further explored in

the ‘Counter-Choreographies’ activity (Section 6.2.3) made the topic of on-line tracking more personal, accessible and creative. In the words of P9, from their questionnaire response: ‘...it makes the critique and ideation of alternatives more accessible, as talking about it as a dance is more relatable’. P9 added that the choreographic approach provided a frame and structure that encouraged relating to data tracking in a personal way. Similarly, P14 found the approach clear ‘while allowing room for improvisation and imaginative and critical ideation’.

Many participants discovered in the workshop the benefits of using their physical bodies to understand and act on online tracking. P16, who contributed to the counter-choreography focused on Zoom, highlighted how the choreographic approach paved the path to ‘solutions that gave agency to our physical bodies: that went totally beyond techno-solutionism’. They added that my approach helped reflect on how data tracking is ‘contained and extended to our physical bodies and that remembering that is important’. P15 also described ‘physicalisation’, or enacting online tracking physically, as a helpful way of growing an understanding of the topics. Other participants mentioned that the embodied and choreographic approach opened new perspectives on the topic: P8 stated that they ‘think differently when moving’; P4 mentioned feeling connected through her body, which allowed processing the topics ‘through different senses’. Some participants emphasised how the use of their bodies created new connections and allowed these topics to be integrated and memorised in a grounded and visceral way; in the words of P14: ‘it sank better in my memory, provided a new way of looking at these topics. Built on a network of associations that felt more visceral. Better grounded to a real-world context’. In fact, the workshop guided the attention and sensitivity of participants to their bodies as a means of critical thinking about issues related to surveillance and their lack of agency within online tracking. P11 commented: ‘I found myself thinking about bodies and control explicitly’. Similarly, P10 mentioned: ‘I think it provides a playful yet smart formulation of what can be complex and layered technologies, relating it back to the body’. Furthermore, this bodily perspective extends to notions of ‘personal agency’, which in turn informs our understanding of ‘the collective’ (P10).

In summary, the results show that all of the participants engaged with the workshop’s embodied and choreographic approach, and that this approach provided them with an intimate, visceral, grounded, accessible, and creative way to critically reflect on how their data are tracked online.

6.5 Discussion

6.5.1 Critical Potential of Counter-Choreographies

This chapter illustrates how I designed and assessed a workshop that proposes a new embodied and choreographic approach that allows people to critically reflect upon data extractivist technologies. First, the empirical findings highlighted how the workshop raised awareness about the limited control individuals have over data harvesting and its use by digital platforms. By doing so, this

research contributes to efforts on the de-alienation of users, which has been advocated by various tech activist groups, such as Tactical Tech. This non-profit distributes resources to promote digital literacy, such as the Data Detox Kit, a toolkit to reduce traces online on mainstream online services (Tactical Tech, 2016a). There are other notable examples of tools and services that enable people to become more resilient in their digital presence. For example, the project My Data Done Right (Bits of Freedom, 2018) helps users keep track of requests to access, remove, correct, or move their data from online services as per GDPR. While they provide fundamental help to people to gain control of their data, people need to be aware that their data is being mis-used or accessed without their knowledge. The *HCCC* workshop contributes with an approach to engage people and grow their critical awareness regarding data tracking. I believe that gaining awareness of data tracking is a first step toward data agency and self-determination.

Second, the findings highlighted the variety of ideas developed by the participants to regain control over their personal data. Once participants became aware of the data extractivist technologies they use, they were able to imagine alternative ways to relate to these technologies tailored to their concerns. This was evidenced by the reappropriation of the choreographic vocabulary I proposed – such as ‘freeze’ or ‘substitute’ – which proved useful in supporting participants to create counter-choreographies (see Section 6.4.2). In some cases, this vocabulary also served as a starting point for participants to develop and formulate their own response strategies.

A main contribution of my workshop is thus to support participants in finding their own counter-choreographies as personal strategies that allow them to meaningfully address their concerns. Thus, my approach contrasts with ‘one-size-fits-all’ approaches to data privacy, which are often the approaches that software tools (e.g. Roy, 2012) and how-to guides (e.g. Proton, 2018) adopt. Instead, I advocate for supporting people by providing tools and vocabularies that allow them to imagine alternatives to their concerns over data extractivism.

6.5.2 Bringing Embodied Choreographic Approaches to Critical Research in HCI and vice versa

The choreographic approach presented adds to the diversity of embodied approaches used in HCI (Hook, 2018; Newell et al., 2011; Pothong et al., 2021). These methodologies emphasise the generative and creative potential of physical involvement (Wilde et al., 2017) in the design and experience of interactive systems (Loke and Schiphorst, 2018). My approach also adds to workshop frameworks that use theatre techniques (K. Andersen and Wakkary, 2019; Elsdén et al., 2017). However, *HCCC* distinguishes itself from previous research by integrating choreographic approaches that recognise movement and embodiment as fundamental to the implementation of change, reflecting on existing power structures and critiquing the status quo. Thus, my approach adds a critical and political perspective to how choreographic methods can be used in HCI.

The results showed how the embodied quality of counter-choreographies has proven particularly useful in making abstract and often obscure technical concepts more tangible, accessible, concrete, and situated in a user’s day-to-day experience. The results also showed that the workshop allowed critical, political, and social issues to be addressed about how digital services insidiously harvest personal data to be experienced by people physically, viscerally, and intimately. The results position my contribution as unique in HCI by bringing criticality to embodiment and embodiment to critical approaches. Connecting with body politics is not new in dance and performing arts (Lepecki, 2015). However, in HCI, these two philosophies, approaches, and communities tend to be distinct, with few recent efforts to bridge embodied methods with ethical considerations (Popova et al., 2022; Spiel, 2021; Tsaknaki et al., 2025).

I contribute with an applicable way of bridging critical methods with an embodied choreographic approach. The *HCCC* workshop proposed concrete physical activities and prompts to facilitate people’s development of counter-choreographies. The latter supported their digital awareness and exploration of new forms of subversion of current technological control and surveillance mechanisms. In line with existing artistic works (such as Alaoui and Matos, 2021; Guffond, 2019; Lee McCarthy, 2022), the activities and tools designed for the workshop engaged people in a critical reflection on the impact of algorithms, in this case, online tracking. They did so by using choreographic prompts and vocabularies that centre their reflective and critical take on technology.

6.5.3 Limitations and Future Works

Although this study may seem limited to participants identified as tech-literate with some familiarity with online tracking, my approach revealed aspects that they had not previously been aware of. This shows how my approach is useful to audiences of various degrees of tech literacy, including professionals in the field.

In future work, I aim to develop a toolkit for the HCI community to use similar activities from embodied sense-making to critique computational systems and algorithms beyond online tracking. I see the potential for the workshop to inspire existing strategies for resisting data extractivism and technosolutionism and to (bodily) empower people to become more resilient in their relationship with technology. I believe that my approach has the potential to feed into multiple critical academic circles, such as research communities working on Experimental AI (Hement et al., 2019) and Graspable AI (Ghajargar et al., 2022). These two areas could benefit from the choreographic approach reported in this chapter to further develop their critical engagement with people. I see the potential for expanding the concept counter-choreographies to enable collective action against technological platforms and algorithmic power (see Chapter 9.2).

Another limitation of this study is that it covers a single activity without follow-up over time. To address this, the next Chapter 7 presents a longit-

udinal study that uses counter-choreography as a long-term intervention that empowers users to critique online tracking algorithms in their daily use of digital platforms. Finally, to broaden access to the *HCCC* research, Chapter 8 presents a set of online choreographic scores, overcoming the constraints of workshop-based delivery.

6.6 Conclusion

‘Dancing not with but against or outside systemic structures!’ —P4

This chapter demonstrated first how I designed a workshop proposing a new choreographic and embodied approach called ‘counter-choreography’ that engages people in critically reflecting on data tracking, and then generate ideas to counter them. Secondly, the findings demonstrated how the workshop supported participants in gaining awareness of their lack of agency regarding online tracking and create counter-choreographies or ideas for reclaiming their agency over their data.

Overall, I discuss how the insights gained from my workshop design and empirical study can inform and inspire practices in HCI that focus on bodies and embodiment to improve algorithmic awareness and criticism.

Chapter 7

Scores Collection

7.1 Introduction

In this chapter, I describe the design of a series of choreographic scores displayed on a website called *Human-Computer Counter-Choreographies (HCCC)* that introduces different aspects of online tracking in people’s daily lives. Here, a choreographic score refers to a system of notation used to prompt movement. I borrowed from the rich history of compositional methods and the diversity of procedures in the choreographic landscape of contemporary dance (Alaoui et al., 2014) that considers various forms of scores from written text to audio-visual material or even computational processes (Jürgens et al., 2021). My approach combines the methodological commitments of artistic research (Borgdorff, 2010) with qualitative longitudinal studies (Lazar et al., 2017) by designing a collection of scores that engaged study participants in reflection and critique of online tracking in their daily lives.

Following the groundwork laid in Chapters 5 and 6, this chapter investigates the extended impact of the choreographic approach developed so far. Specifically, it explores the potential of counter-choreographies as long-term interventions that empower users to critique online tracking algorithms in their daily use of digital platforms.

The following questions guided my research:

- RQ1: How to design a series of choreographic scores that reveal data tracking algorithms?
- RQ2: How does the engagement with the scores on a daily basis support participants in critically reflecting on data tracking?
- RQ3: How does daily engagement with the scores inspire forms of awareness raising that lead to participants behavioural change?

I describe the design of the website *Human-Computer Counter-Choreographies*, which contains twelve scores for counter-choreographies ¹ for each score, custom style, and programming scripts were created to emphasise data tracking concepts. Each score points to the entanglement of our bodies with algorithms in the gestures we perform day-to-day and the traces they leave behind. This

¹Available at: <https://cci.arts.ac.uk/jchicau/scores/web/everyday-choreographies.html>

collection of scores invites users to reflect on their movement patterns and imagine ways to move against or resist tracking.

Finally, I provide insights into an empirical study with five users of the *Human-Computer Counter-Choreographies* website over two weeks. Participants were asked to record their responses to each score using drawings, photographs, video and/or audio recordings. The study's insights include the impact on increasing awareness and reflection on agency concerning online tracking, behaviour change toward tracking, and the process of embodiment in responding to the scores, which proved to be meaningful and impactful for the participants.

This chapter complements and builds on the research presented in Chapters 5 and 6. It provides a deeper understanding of how the concept of 'counter-choreography' can engage people critically with the topic of online tracking. Although the performance piece and workshop series proved effective in raising awareness and reflection of online tracking, both lacked a longer-term engagement to understand its effects on participants' lives. The *HCCC* scores allow people to engage with counter-choreographies daily, providing intimate insights into their experience.

My contribution in this chapter is two-fold. First, I present design insights on building a web-based platform that features a collection of 12 scores, engaging people in reflecting on the tracking of data in their lives. Second, I share my empirical findings on the effectiveness of scores in raising critical awareness of the prevalence of tracking, including the feelings involved in the process, reflection on their agency (and lack thereof), and change in behaviour toward online tracking. Moreover, I present extensive insights on the role that embodiment played in the process of gaining awareness of data tracking.

7.2 Design Process for Making the Scores

7.2.1 Artistic Research and Criticality

In this section, I present my artistic research based on an autobiographical process that led me to produce the *HCCC* website, which displays a collection of choreographic scores to reveal online tracking to users. The design process revolves around my dance background (see Chapter 1.1), which informed the design of the *HCCC* scores to gain a deep and long-term understanding of its impact on people.

The collection of scores presented in Section 7.2.2 was designed to uncover different aspects of online tracking in people's daily lives. Scores can be defined as a set of short instructions (see Chapter 2.2.1) to which participants respond daily through physical enactments (e.g. walking or making hand gestures). Through the scores, participants experienced their own data, reflected on their daily online routines, and developed personal counter-choreographies.

My concern in sensitising users to topics related to online data tracking is in line with the critical approaches described in Chapter 3.2.2. By responding to the scores, participants embody concepts related to online tracking, to increase awareness, and to provoke reflection on their agency (or lack thereof).

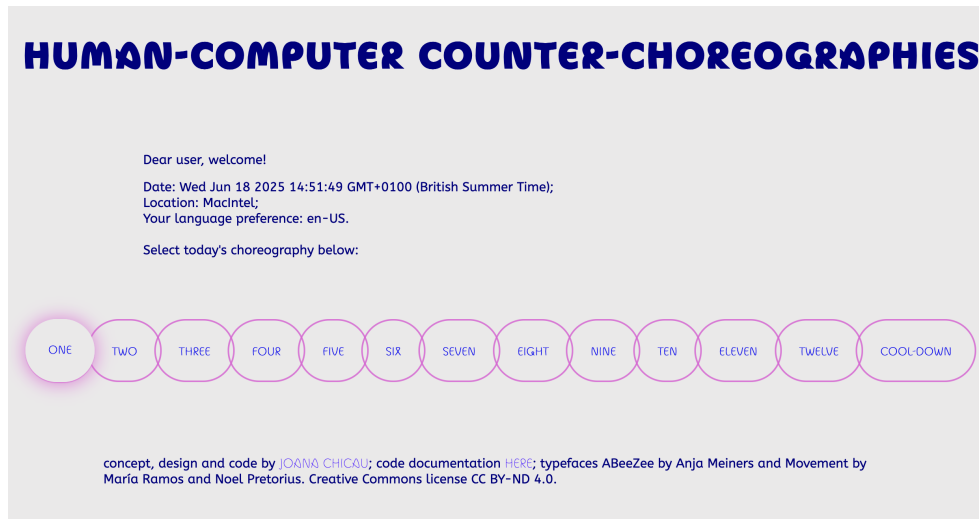


Figure 7.1: Landing page of the *HCCC* scores website used in the study (2025).

The scores invite users to reflect on the prevalence and evasiveness of such algorithms to bring about social change.

7.2.2 Scores Collection

For this study (described in 7.3), I designed a collection of 12 scores (see Table 7.1 for a detailed description and Appendix B for visual documentation) accessible through a website. I explored the format of ‘scores’ in involving people to reflect on data extraction in their daily lives. For each score, study participants responded following the embodied tasks, making abstract concepts related to data tracking more tangible (see Section 7.4.4). My goal was to physically engage the participants to gain an embodied understanding of on-line tracking technologies and invent ways to resist them.

The choice of ‘choreographic scores’ as a format speaks to my research on choreography, which has informed my approach to designing this work (see 2.2.1). Choreographers, such as Augusto Boal (Boal, 2019) and Yvonne Rainer (Wood, 2007), shaped the way I designed choreographic prompts using movement vocabulary that favoured daily gestures that were performed by people both offline, such as standing and moving around, and online, such as clicking or scrolling.

Although I am inspired by the concept of cultural probes (B. Gaver et al., 1999) and probe design frameworks (Derix and Leong, 2019), my approach differs in many aspects, such as the stage at which it is implemented. Cultural probes, or simply probes, are sets of tasks designed to spark meaningful interactions with users, providing valuable information on their activities, concerns, and perspectives (Boehner et al., 2012; W. Gaver et al., 2004). Probes are usually deployed in the pre-design phase of a project and serve to inspire future designs (Sanders and Stappers, 2014). The *HCCC* scores and the website have instead been presented as a prototype. The fact that study participants were asked to individually and autonomously complete the scores, with little guidance from the designer (Boehner et al., 2007), is a similarity shared with the probes.

<i>Score</i>	<i>Description</i>
1	Grab a pen and paper or a digital equivalent annotating tool. List the apps and online services you use daily (e.g.: weather or banking apps, maps, social media, or other websites you frequently access using your phone or computer). Around each app list the data you think the app collects (e.g.: date of birth, gender, location, phone number, audio data, photos, clothing size, sexual orientation, religious or philosophical beliefs, trade union membership, salary info...) Create a movement for each type of data. Record (e.g. in the form of video or drawings) those same movements in order from most ‘personal’ or intimate to least.
2	In the previous score, you identified what you consider as the most ‘personal’ or intimate type of data; Note down when you think that data is tracked, including if you’re explicitly asked for that data on apps/ online services. At the end of the day, record yourself performing that movement the same number of times as you noted down.
3	Choose one of the apps or online services you use day-to-day. List all the gestures you perform in the app, such as: scroll click select save type trash play swipe... Substitute one of the gestures for another movement of your choice. Record your new movement, for e.g. in the form of a drawing or a short video.
4	Today, perform any online gestures at 50% intensity. For e.g. today, when scrolling or clicking, instead of doing it normally, do it at 50% intensity, this can be interpreted as less speed, frequency, etc.
5	Randomly perform a gesture online. For e.g. when accessing an app or website randomly perform a gesture (e.g. randomly click or pause...), instead of the intended one. Repeat this five times anytime throughout the day.
6	Note down every-time you click on a ‘cookie’ pop-up. At the end of the day clap for each time you performed that gesture and record the sound.
7	Today, trace your movement across different websites and apps. For e.g. like drawing a map on a paper, you can use different colors or line thickness to signify different website categories/ apps. Take a picture of your drawings to upload in the form below, then erase your traces!
8	Predict your next movement online, then don’t do it. Repeat this 10 times today.
9	Take a deep breath for each time you scroll over 75% of a webpage, today.
10	Freeze for 2 seconds for each AD you see on your screen today. At the end of the day make a drawing of your ‘AD-self’, how do you look like in the gaze of advertising?
11	Create your own score of a ‘counter-choreography’ for someone else; for e.g. you can get inspired by previous scores! Focus your score on data you consider to be personal or intimate and the online gestures associated with it; Take a picture of the score you made and upload it to the form below. P.S. you can optionally send it to the person you had in mind, but you don’t have to!
12	Imagine a dance floor free of tracking, where you can move like no one is watching! Record a choreography as if you were dancing in that dance floor. For e.g. you can record by drawing, writing, via audio description, or video capture... At last, give a title to your ‘counter-choreography’.

Table 7.1: Overview of the 12 scores.

The intention behind the design of the score collection was to gradually guide people in learning about different aspects of the tracking through their engagement with different forms of bodily expression. The first set of scores (1-2) served as an introduction to online tracking and drew people’s attention to the data collected in their day-to-day lives by the apps and online services they used. A definition of online tracking was given at the top of the webpage in score 1. For these two initial scores, participants were invited to reflect on how personal or intimate they felt about such data. This aims to engage people on a personal level, which speaks to their life circumstances, to relate to the topic of tracking in a meaningful way.

The subsequent scores (3-9) investigate various gestures performed online, primarily associated with user interaction in apps and websites, such as scrolling, clicking, or swiping. By examining these gestures through a choreographic lens, these scores aim to bridge the gap between seemingly mundane movements and the data extracted from them by web analytics. In doing so, they shed light on how online tracking is inextricably linked with the quantification of user engagement (Bonini and Treré, 2024).

The score number 10, ‘Ad-Self’, establishes a crucial connection between various movements, gestures, and traces left online and how these data points are utilised to personalise content delivery. Specifically, it reveals how user behaviour data is used to inform targeted advertising, often in the form of custom ads. Although pinpointing the exact data triggers for specific ad placements can be challenging (Bucher, 2017), this score provides a critical first step in urging people to recognise the profound impact that their online behaviour has on the content they encounter.

The final two scores (11-12) invite individuals to create their own counter-choreographies in the form of scores. The first score prompts users to ‘create a counter-choreography score for someone else to dance to’. The second celebrates privacy and non-extractivism by inviting people to ‘imagine a dance floor free of tracking, where you can move like no one is watching!’. Throughout the scores series, individuals are encouraged to challenge tracking; however, it is in these last two scores that this theme is most explicitly conveyed through the act of making counter-choreographies, which underscores the potential of scores to foster appropriation and interpretation (Folkerts, 2016).

The last button, named ‘cool-down’, opens a webpage that reminds participants of attending the post-study interview. It also provides a link to learn more about privacy-enhancing technologies and suggestions for tools that can help prevent tracking.

The design of the scores was based on previous work developed as part of Chapters 4, 5 and 6 (see Fig. 7.2). The basis for scores 2, 3, 7, and 10 were the exercises developed for the workshop series. The exercise ‘Mapping Everyday Tech’ (see Section 6.2.3) inspired the initial score. The prompts that invited workshop participants to respond through movement sequences (see Section 6.2.3) inspired the physical tasks throughout the scores.

Scores 5 and 9 were based on the performance piece. Score 5 (‘Randomly perform a gesture online’) was based on the randomisation script used to

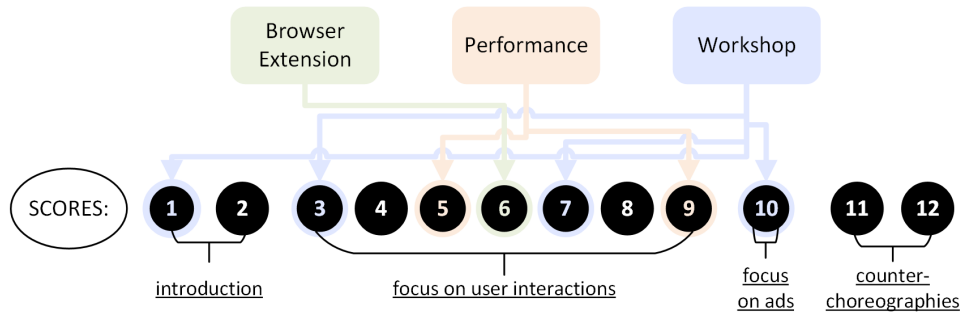


Figure 7.2: Connection between the scores and work from previous chapters.

overlap textual elements and images (Fig. 5.5). Score 9, which asks one to take a deep breath after scrolling over 75% of a website, was based on the script that displayed scrolling metrics (Fig. 5.2).

Score 6 ‘The Sound of Cookies’ was inspired by the development of the browser extension (Chapter 4). It asked participants to make a sound (clap) for each cookie pop-up they encountered, embodying the ‘accumulation’ (Rosenberg, 2012) of tracking encountered throughout the day. The remaining scores were created to fill the gaps and support a thorough and gradual understanding of online tracking techniques.

The 12 scores on the *HCCC* website were designed to offer a long-term experience integrated into people’s daily routines. Through the creation of these scores, I further developed a ‘choreographic vocabulary’ that invites reflection on online tracking, allowing for a more comprehensive exploration of the topic than was possible within the time frame of the performance and workshop. In addition, the scores were designed to be used without any guidance, unlike the performance and workshop that depended on my presence and facilitation.

7.2.3 Interface Design and Custom Scripts

I designed the website layout to be easy to navigate, so participants could immediately find the scores they needed to access each day. For this reason, the landing page displays the scores numbered in order of access from 1-12 (see Fig. 7.1).

To better communicate concepts related to tracking, custom scripts and interactions were designed to emphasise those concepts. For example, starting with the landing page, I added scripts that extracted typical parameters used in Fingerprinting. It included screen dimensions and resolution, time zone, and language preferences, among others (see Fig. 7.1).

Some of the scripts developed for the performance (Chapter 5.2.4), were integrated into the design of the *HCCC* website. For example, score 7 ‘Tracing Movement’ (Fig. 7.3) used the X and Y coordinates of the cursor to draw a trail with pink dots to emphasise user tracking when interacting with websites. A similar effect was used when the cursor was moved in the performance, creating a trail sequence with images of a human fingerprint.

Another example was the webpage for score 9 ‘Breathing Scrolling’, which quantified the scroll percentage of the user, to highlight this type of user

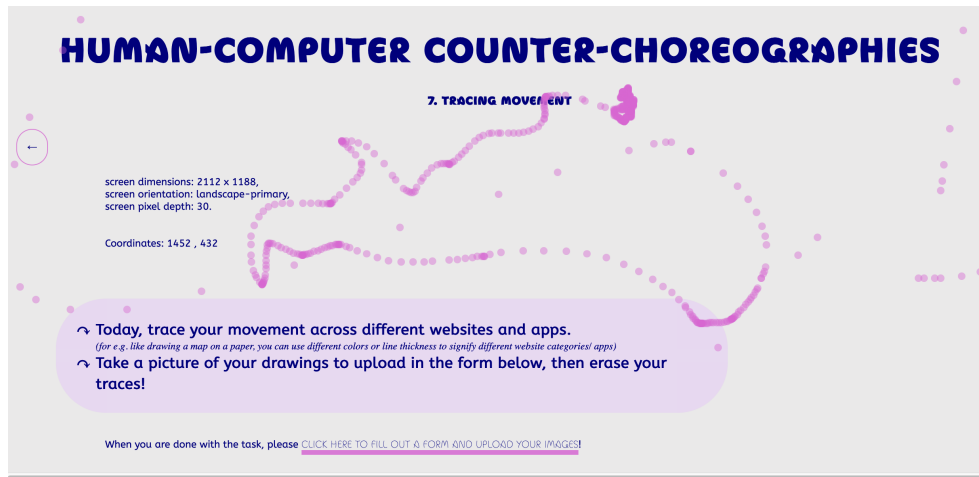


Figure 7.3: Score 7, part of the *HCCC* scores website used in the study (2025).

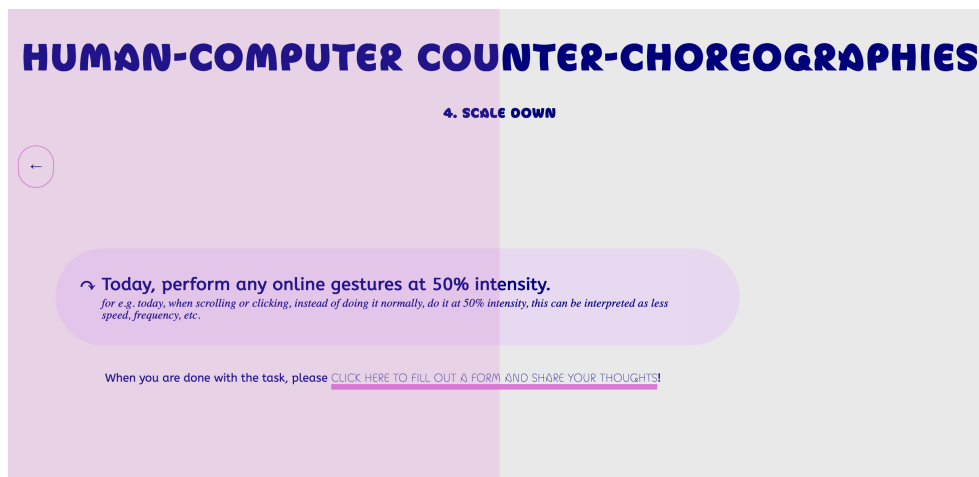


Figure 7.4: Score 4, part of the *HCCC* scores website used in the study (2025).

metric. In the performance, the same script was used to illustrate how scrolling triggered tracking requests (see Section 5.2.4).

In addition, I designed new custom interactions, as in score 4 ‘Scale Down’ (Fig. 7.4), which has an animation that covers the background with a pink colour up to 50% to play with the idea of reducing the intensity of online gestures to half. In score 5 ‘Randomise’, a button, when clicked, changed position randomly on the website to emphasise the concept of randomness.

The sixth score on ‘Cookies’ (Fig. 7.5) displays a pop-up that says: ‘Feeling hungry? [cookie emoji]’. Once the pop-up was dismissed, a JavaScript function checked whether the user’s browser allowed cookies. If cookies were enabled, the webpage displayed the message: ‘Cookies enabled? true’.

The website itself does not use algorithms to collect data on participant interactions and follows the W3C accessibility standards.

7.3 Scores in Action

7.3.1 Study Design

Based on the results of previous activities that included a performance piece (Chapter 5) and workshop series (Chapter 6), this study focused on study-

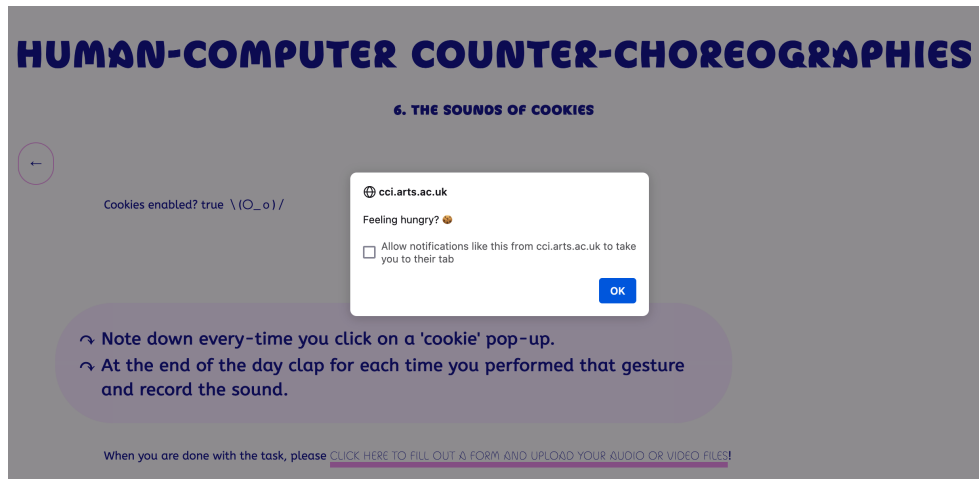


Figure 7.5: Score 6, part of the *HCCC* scores website used in the study (2025).

ing the effects of counter-choreographies in people’s lives. I was particularly interested in understanding how a more intimate, deeper, and longer-term involvement with counter-choreographies could engage people in reflecting on data tracking.

I followed the recommendation of Lazar et al. to limit the study to a maximum of two weeks to sustain engagement (Lazar et al., 2017). During this time, participants were asked to respond to 12 choreographic scores available on a website (described in 7.2.2). Each participant performed the same task: selected a score in order 1 to 12, followed the instructions in the score, and finally completed an online form.

Participants responded to the scores in various ways by creating a short movement sequence or series of gestures to reflect on online tracking. In addition, participants documented their responses through photographs, videos, and audio recordings and uploaded that material through the online form. The time estimate for completing each score depended on the participants’ engagement, but it was estimated to be an average duration of 30 minutes.

Participants were also asked to attend a one-hour interview at the beginning and end of the study. The study was conducted in June 2024.

In-the-wild Longitudinal Study

Research in the wild involves the design, prototyping, implementation, and study of technology in its natural context to uncover how it influences people’s daily routines and practices (Rogers and Marshall, 2017). Given that technology is now deeply integrated into everyday life, HCI researchers have recognised the importance of conducting in situ studies to capture experiences and gather insights from people in their homes and other real-world settings.

In *HCCC*, I focus on how the scores enabled the creation of movement sequences and physical tasks for people to reflect on online data tracking in their daily lives. In line with the research in the wild, the study was integrated into the routine of people, with the *HCCC* scores most often performed at home.

Participants

An open call detailing the study was launched in multiple formats: website, image, and PDF to be easily circulated across my networks, mailing lists, and social media. The aim was to reach people without a technical background or expertise in the topic, in contrast to previous studies, such as the last iteration of the workshop (Chapter 6), in which participants had a higher level of technical literacy.

A total of six people were initially recruited, one dropped out after the first interview, and the data collected from her was excluded from the analysis. I intentionally sought a diverse set of participants, including gender and ethnicity, to centre the experience of those who are most affected by algorithmic injustices. However, given the small sample size, various demographic aspects are not represented and the group is limited to an age range of 23-55 years. The five participants who participated throughout the study consisted of a Chinese student, female, 23 years old; a British student, male, 25 years old; a Colombian dancer, female, 33 years old; a British mathematician, female, 36 years old; and a British training consultant, female, 55 years old. At the time of the study, the participants lived in the United Kingdom or Europe.

A £110 gift card payment was offered to each study participant, based on an estimate of the time required for participation, taking into account the hourly London living wage.

Methods for Data Collection and Analysis

To ensure that I selected as diverse a group of participants as possible, demographic data was collected during the recruitment process, including their age, location, gender, profession, and prior knowledge of online tracking (on a scale of 1-5).

Once the group was selected and agreed to participate in the study, they were asked to complete a short form (see the Appendix A) that listed three questions after completing each score.

1. ‘What made you decide to respond to the score the way you did?’
2. ‘How did you make the connection between the score and online tracking?’
3. ‘Anything that wasn’t clear from today’s score?’
4. ‘If you have been asked to document today’s score, please upload your response’

An online call of one hour was held before and after the study; the first call was to introduce the participants to the study and guide them through the first score, so they could test access to the interface and answer any questions related to it. The second call consisted of a semi-structured interview, which included the following questions:

- ‘At the beginning of the study you said your knowledge of online tracking was X out of 5 – has it changed after the study?’

- ‘Did you feel your attitude towards data extraction changing over the two weeks? How?’
- ‘What connections did you make between the scores and your personal/professional life?’
- ‘Did you experience any difficulties using the scores / following the activities?’
- ‘How did you make the connection between online tracking and choreography?’
- ‘Can you describe how was the concept of counter-choreography?’
- Did the scores support you in thinking of ways to counter tracking? (If so, how?)’
- ‘Any ideas how the scores can be improved?’

The responses collected from the online forms alongside the interview transcripts were evaluated through a reflexive thematic analysis (Braun and Clarke, 2022). The thematic analysis process followed a six-phase structure of familiarisation, coding, theming, review, definition, and documentation (Braun and Clarke, 2022). These were not part of a linear trajectory but integrated a recursive process, in which my supervisory team (Prof. Rebecca Fiebrink and Prof. Sarah Fdili Alaoui) and I returned to revise work done in previous phases. For the initial phase of familiarisation, I printed out all the data collected from the research activities and made notes; for the next phases, I used online documents such as spreadsheets. Coding and analysis primarily followed an inductive approach in which codes and themes were derived from the data in the participants’ responses.

Participants have been assigned unique IDs from C1 to C5 for anonymisation purposes.

Before starting the study, participants signed a consent form that provided details on data collection and anonymisation, as well as their right to withdraw. The study plan was approved by the Research Ethics Committee at my university. All digital data has been securely stored on servers associated with UAL, in accordance with GDPR.

7.4 Results

From the data analysis, five high-level themes were generated.

The first explores how participants’ awareness of online tracking developed, with subthemes addressing prevalence, intrusiveness, and invisibility; user interactions; ads and targeted content; personal information and surveillance.

The second theme underlines the feelings involved in gaining awareness of online tracking.

The third theme concerns the reflections of participants on agency and consent online (and the lack thereof).

The fourth theme concerns how centring bodily experiences supported participants in reflecting on online tracking. The two subthemes emphasise reflections on the process of enacting online activities and how that process fostered a sense of regained agency.

The final theme relates to behaviour change towards online tracking, with a subtheme on reclaiming time and breaking habits.

In the following sections, I expand on each of the themes.

7.4.1 Growing Awareness of Online Tracking and How it Works

All five participants mentioned during the interview that they have increased awareness of online tracking. In the words of C1, in the last interview: ‘... [online tracking] was kind of like, vaguely floating around my head, but then definitely after these two weeks, it’s like brought it into focus’.

In the following sections, I detail the most prominent aspects of online tracking that participants became increasingly aware of.

Awareness of the Prevalence, Intrusiveness and Invisibility of Online Trackers: The participants mentioned having raised awareness of the prevalence, intrusiveness, and invisibility of tracking.

During the interview, C1 mentions that the study helped her realise that there is more to online tracking than what she knew, and that she has re-evaluated her assumptions about her knowledge of tracking. She began the study rating her knowledge of online tracking as a 3 (on a scale of 1-5), but in her final interview, acknowledged that a 2 was more accurate. This was noticeable in her response to score 2, which asks one to note down each time data she identified as the most personal or intimate (in score 1) were being tracked. In her case, these data were her name, and she referred to the frequency at which it was extracted by online services as ‘alarming’. In score 6, on counting cookie pop-ups throughout the day, she pointed out once growing awareness of the prevalence of tracking and how there are probably more instances than the ones she recorded.

C4 highlighted the discrepancy that she felt in the intimate experience of being on her phone and the exposure of her actions to tracking mechanisms operating on the device. During the interview, she mentioned: ‘...you think that you’re on your phone doing something, really intimate that nobody’s watching. But actually, it’s been tracked, you know, like it’s being watched’. She expands on this idea in her response to score 12 (which invites participants to dance like no one is watching): ‘This made me reflect on the fact that I am not aware that everything I do online is tracked. I sometimes forget this and this exercise, to record myself made me think that actually I am kind of “being observed/watched” more than I think’.

These examples highlight the participants’ realisation of the prevalence, intrusiveness, and invisibility of tracking. This was a recurring theme throughout the study.

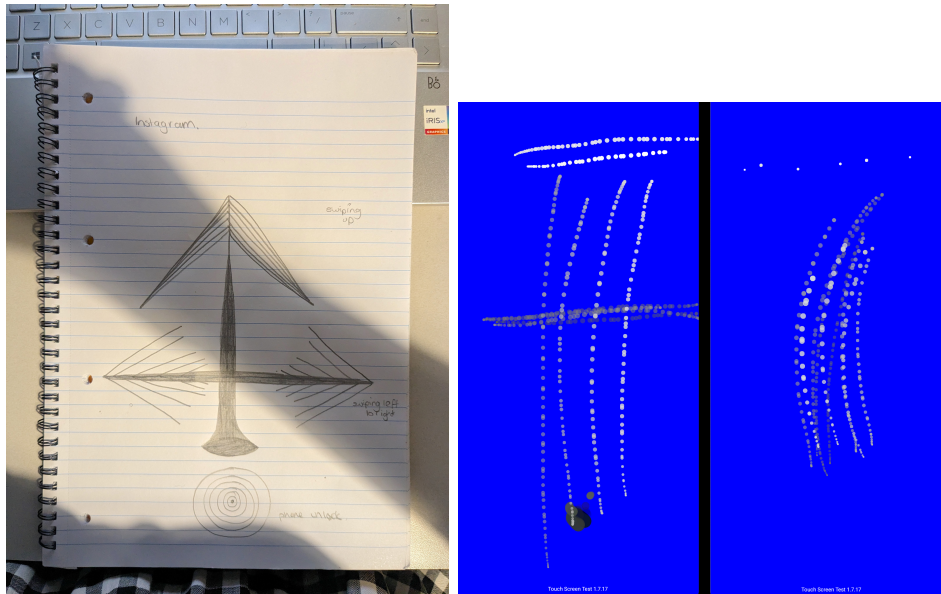


Figure 7.6: Drawing of a map of the gesture of scrolling on Instagram (left); screenshot of finger traces while swiping on Instagram (left) and YouTube (middle) in response to score 7, by C1 (2024)

Awareness of Online Tracking in User Interactions: This sub-theme illustrates the connections that participants made between user interaction and online tracking.

During the interview, C1 reflected on her finger scrolling (score 9) which she did not know was a form of online tracking: ‘I didn’t think about like the finger scrolling on the screen could be tracked and recorded and that made me think about like, why would they need that?’. In her response to score 4 and 5, she reflected on the gesture of scrolling through Instagram at different speeds and how that might be quantified and perceived as user engagement.

For score 7, she created a drawing using a ‘Touch Screen Test’ app to trace how her finger swipes on Instagram, YouTube and Gmail. As seen in Fig. 7.6 it resembles a choreographic notation as she mapped the drawing qualities according to the movement performed: ‘the thicker the liner the more times that travel is taken and the bigger the arrow the longer the travel (or swipe). It was fun!’. Indeed, C1 mentioned that this was her favourite score.

Other participants also highlighted aspects related to the tracking of user interactions. C2, in her response to the score 8 (on predicting the next movement online, to then avoid doing it), noted that online environments are designed to grow user engagement, for example, by inviting users to click buttons they encounter. C3 reflected on how gestures and touch are related to online tracking (score 5) and how even the smaller gestures can be tracked (score 3).

C5 during the interview specifically referred to Google and Microsoft ‘following’ her as she is always signed into her accounts. In her response to score 5, she reflected on instances of using her phone when travelling abroad and how location tracking and her search activity at local attractions affected the ads she encountered. In the interview, she recognised that her use of various apps and services generated a digital footprint of her data.

As mentioned in Section 7.2.2, the scores 3-9 were designed precisely to

2. Getting personal

- When I download a new app.
- When I am looking for a place in the city.
- When I upload photos in Instagram.
- When I send voice messages or speak on the phone.
- When I write, chat or call to my friends and family.
- When I post something related with my political position or my beliefs.
- When I open the camera to scan a code.
- When I register in some online page.



Figure 7.7: Responses to score 2, text annotation (left) and video still (right) by C4 (2024).

emphasise daily gestures related to user interaction. As evidenced by the participants' testimonials, the scores succeeded in bringing to light how gestures and user interactions performed on our devices are intrinsically connected with forms of data extraction.

Awareness of How Personal Information is used in Online Tracking: This subtheme explores the growing understanding of participants about how their personal information is used and to what extent it is collected through online tracking.

For C5, the question of how much personal information was given away through the use of websites and apps became obvious in score 2, and she continued to reflect on it as the study progressed. In her interview, she highlighted a recent episode when using comparison sites for insurance coverage, which required her to provide extensive amounts of personal information.

Similarly, C4, in her response to score 2 (see Fig. 7.7), has written: 'I made the connection by paying attention during the day to the apps and website I am using and then noting down the type of data I was delivering. Then, I realised that it is very intimate and personal information that is always getting exposed, but I am already used to giving it. I have already even the autofill in the phone and computer'.

Finally, on her 'counter-choreography' (score 11), C3 reflected on her desire for privacy and not being 'spied by others'.

As illustrated in this section, throughout the study, participants referred to the intimacy and personal nature of the information collected by the various online services and apps they use.

Awareness of the Connection between Targeted Content and Online Tracking: In the previous section, participants highlighted the increased recognition of how their personal information is used in online tracking. This subtheme specifically addresses how their personal data and their behaviour online feed ads and targeted content. Score 10 specifically emphasised this aspect that resonated with most of the participants.

C1 found this score one of the 'most revealing' and reflected on how the ads can portray her as a mirror of her actions online. After responding to score 10, C2 felt more conscious of the personalised content that was shown. He reflected on the connection between the ads and his movement patterns

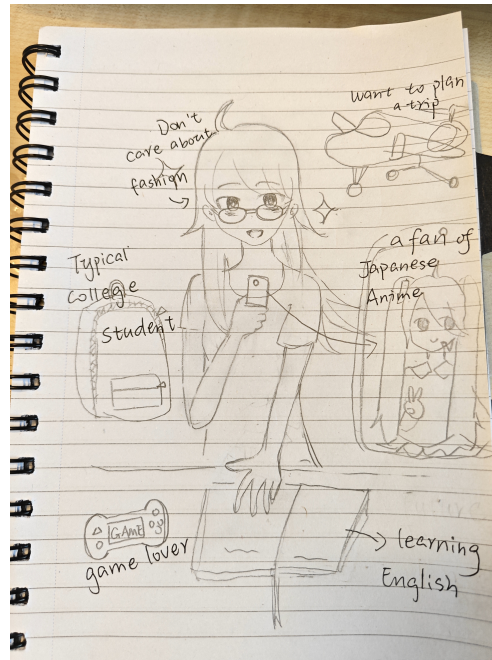


Figure 7.8: Self-portrait in the gaze of advertising, response to score 10 by C3 (2024).

performed online, including personal information given away through website and app usage.

C5 during her interview said: ‘...I play games online and they’re free games, and I suppose the adverts that come to me might look at what I look at online. [...] So I guess the tracking might see that I look at clothing stores or eBay or [...] Teemu...’. She added that score 10 was her favourite, although she found it amusing, it was also concerning to realise how accurate targeted ads were: ‘I paid close attention to every advertisement I saw. I collected them and then drawing pictures. So the ad targeted at me looks like they were actually very precise, which isn’t great, but I had a lot of fun drawing’.

C3 originally thought that the way ads were displayed was a coincidence, but after the study she knew it happened because of data tracking. In her interview, she mentioned being surprised at the accuracy of the ads in capturing her shopping habits.

The 10 score, the ‘Ad-self’, proved to be popular, C3 (see Fig. 7.8), and C5 felt that drawing was particularly engaging and stimulated their creativity.

Awareness of the Relationship between Tracking and Time Spent Online: Most of the participants explicitly referred to having increased awareness of the relationship between how the tracking increases with the time spent online.

C4 highlighted the fact that data extraction accumulates over time in her response to score 4 (which asks to slow down and perform any online gestures at 50% intensity) and later reiterated this in her interview. C2 referred to the same accumulative aspect in response to score 5 (on randomly performing gestures online) and C3 in response to score 6 on clapping for each ‘cookie’ pop-up (see Fig. 7.9). This aspect is further elaborated in Section 7.4.5, as participants take action to reclaim their time and reduce their online engage-

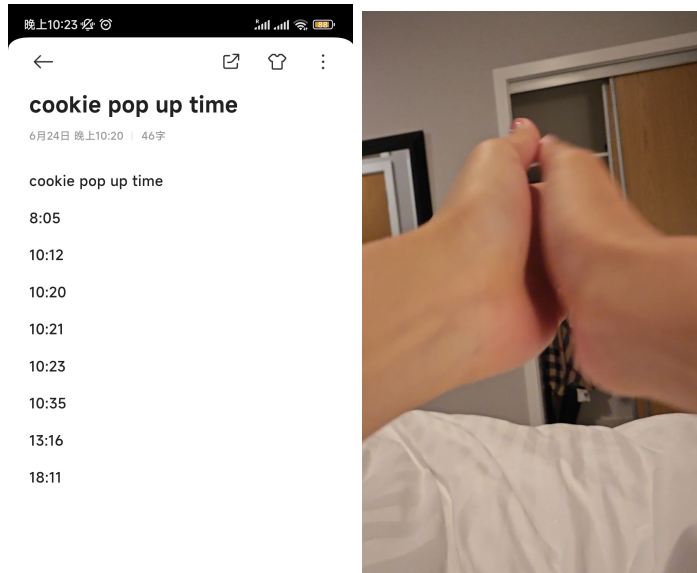


Figure 7.9: Response to score 6 by C3 (2024).

ment.

Awareness of the Relationship Between Data Extraction and Surveillance: The engagement with the scores opened reflections and further connections between data extraction and surveillance.

C3 mentioned not being able to trace the point ‘she lost her privacy’ in China. She raised her concern about state surveillance and how it would be important to raise awareness of ways to protect privacy online. She mentioned how people feel they don’t have a choice: ‘We feel that we are powerless cause we don’t even know when we lost our privacy. At least in the UK, they will tell you that they are collecting [data] like a sign in the shopping mall or something written CCTV is operating, but you know in my country there’s just no warnings about our privacy, we don’t really care about that’ (note: minor grammar corrections on original quote for readability).

C4 also mentioned state surveillance in Germany regarding publicly demonstrating solidarity with Palestine.

During the interview, C1 expanded her reflection to the impact of other prevalent technologies that make use of AI, such as training data sets for emotional recognition. She also reflected on surveillance in other contexts, such as in the workplace.

Beyond increasing awareness of online tracking, the scores allowed participants to explore their connections to forms of surveillance, including workplace and state surveillance, as described above.

7.4.2 Feelings Involved in Gaining Awareness of Online Tracking

Participants referred to a range of feelings associated with growing awareness of tracking, including anxiety, paranoia, powerlessness, nervousness, apathy, anger, vulnerability, boredom, happiness, peacefulness, a lack of control and freedom. For some participants, these feelings were intertwined; for others,

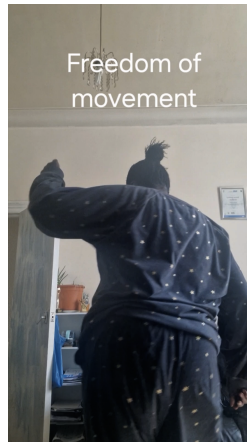


Figure 7.10: ‘Dancing like no one is watching’, screenshot of video response to score 12 by C5 (2024).

they progressed from negative to positive over the course of the study.

During her final interview, C1 mentioned feeling anxiety and paranoia when thinking about data, as well as powerlessness when realising how much data has already been collected by the online services she used. In her response to the first score, she wrote: ‘I thought about what makes me nervous or paranoid about using each app and wrote it down around each app. The connection is an emotional or guttural reaction to each app’.

Similarly, C2 reported feeling anxious while using the internet and the speed at which content is fed. In his interview, he noted how the 9 score (on ‘deep breathing’) supported him in calming anxiety. He also highlighted score 12 (on ‘dancing like no one is watching’) and how it enabled him to feel happiness and freedom, as he has written: ‘Dancing is a form of expression, but the way you dance has been skewed if you are dancing in front of the public. But dancing in private gives you a sense of freedom, where you can move your body how it wants to move without the thought of judgement’. He reiterated this aspect in the final interview, comparing dancing in public vs in private correspondingly with feelings of judgement vs freedom, and relating these feelings to online tracking and surveillance.

Comparably, C5 connected her score 12 (Fig. 7.10) with the feeling of freedom, which contrasted with her feelings of having to give away a lot of personal information. She recalled an earlier episode in which that had happened and how she wished it had been less evasive.

C3 mentioned feeling powerless during the interview, particularly with regard to websites in China, which do ‘not even bother’ to add cookie pop-ups (score 6). She added that she moved from apathy to anger as she further reflected on how companies will find smarter ways to track her. Although C3 reported that these feelings changed over time, in her analysis of score 11 (Fig. 7.11), she connected different movement qualities with her emotions toward tracking: first soft and repetitive trying to evade detection; then fluid representing panic and feeling out of control; and finally more peaceful, compromising with the fact that she cannot avoid tracking.

Finally, feelings of vulnerability and boredom also emerged: C4, in her

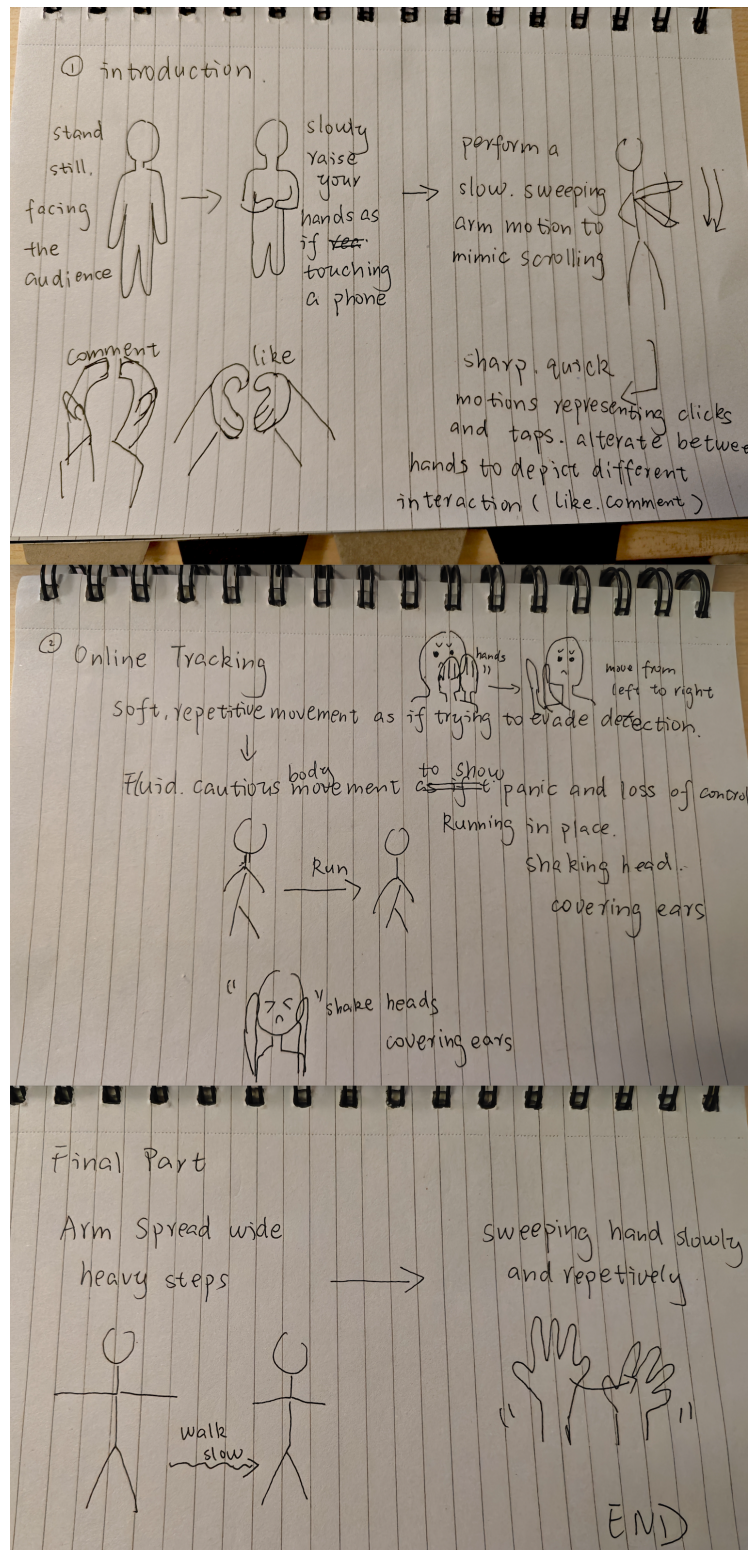


Figure 7.11: Three drawings in response to score 11 ('counter-choreography') by C3 (2024).

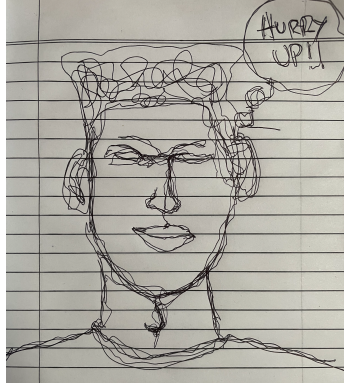


Figure 7.13: Self-portrait in response to score 10 by C2 (2024).

consent in online tracking.

As this theme demonstrates, the scores prompted participants to reflect on their agency and consent (or lack thereof) in the context of online tracking.

7.4.4 Physicalising Online Tracking

From the beginning of the study, the scores brought people’s bodies to the centre of attention. This fourth theme explores the reflections of the participants on the role of embodiment and how physically performing the scores was meaningful and impactful in their understanding of online tracking. This theme is divided into (1) Reflections on the Process of Enacting Online Activities and (2) Physicalising Tracking as a Means of Fostering a Sense of Regained Agency.

Reflections on the Process of Enacting Online Activities: This subtheme gathers reflections on both the participants’ process of enacting online activities and, subsequently, gaining an increased awareness of the role of their bodies within that process. Initially, this subtheme was split into those two aspects, although as I gathered testimonials, it became apparent how intertwined they were, which led me to decide to group them as one.

During the interview, C1 mentioned that physical enactment feels more impactful and memorable, in her words: ‘When you can map like a virtual thing to like a body thing. It’s like you’re making a note with your body and it helps you remember. It helped me remember’. She highlighted embodiment as a key element in growing awareness of online tracking. For example, in response to score 1, she mentioned making sense of data tracking through movement explorations as she exemplifies: ‘I decided to use actions that made sense (to me) with each track. For example, for name, I chose a heart action with both hands. Every action I chose was to do hand movements because I am shy’. Score 3 (Fig. 7.12) enabled her to draw a direct analogy between the physical path of her finger on the screen and the corresponding tracking of her actions online. During the interview, she added: ‘Because I made those movements on my paper, it made an impression on my body and in my memory so doing all these movements to show the tracking has definitely made me think about them more and they’ve made more of an impact. Had I just,



Figure 7.14: Video stills from response to score 3 by C4 (2024).

like, read it in an article or something like I'd be thinking about it, but I could move on'. Another example is score 7 (Fig. 7.6) — which involved drawing — it prompted her to reflect on her swipe actions across different apps. For score 11 (Fig. 7.17), she created a series of physical movements that would accumulate with phone usage to test how it affects a person's engagement online. Her strategy was to 'record' those actions 'in the body'.

C2 progressively reflected on the role of embodiment, starting with score 2: 'It was a pattern of movements that resonated with how I felt for each of the data'. This idea of patterns speaks very closely to choreography (see Chapter 1). In response to score 3, he uses the expression 'making sense' to explain how he engaged with it. Additionally, he reflected on the sense of flow in the movement created like when scrolling online, and in score 4, he drew a connection between the speed of actions and the data extracted. During his interview, C2, also reflected on how scores and physical enactment provided a creative way to reflect on tracking: 'I think dance gives it another way to think. It's linking something creative with something technical or statistical'.

Similarly to C1 and C2, for C4, score 3 (Fig. 7.14) helped reflect on online tracking through enactment: 'I was observing how my hands have adapted to the phone in a way that the moments start to be very natural, almost like the phone is part of my body'. In the interview, she added how daily gestures performed online become '...so automatic [...] it becomes very mechanical'. In her response to score 6, she reflected on forming a new connection between the sound of clapping and the clicking on cookie pop-ups: 'I was already relating the sound of the clap with the "cookie pop-up" in my mind'. She mentioned during the interview how over time she started to imagine a space made up of the gestures performed daily: 'I could see like how I am executing a choreography all the time'.

In response to score 1, C4 reflected on the relationship of bodies towards data, and how her 'body feels' knowing that data is being extracted. She highlighted score 9, which involved breathing, as helpful in bringing her attention back to her body while using the phone apps. The act of taking a deep breath led to a pause and reflecting on the meaning of what she was doing online: 'What's the meaning of this? [...] a breath is not just like the act of inhaling and exhaling, but they are taking a pause'. She mentioned that it helped grow

11. Viral Dancing: Create your Own Counter-Choreography!

Whenever you are in a public space using an app or online service that you consider, take some seconds to “show” to the app where you are and who is around you by doing small gesture.

At the end of the day performed the gestures you did to show the surrounding to your App.

Figure 7.15: ‘Counter-Choreography’, in response to score 11 by C4 (2024).

awareness of the surrounding ambience and detach from the narrow focus of the screen: ‘when I’m using the phone everything becomes very narrow and like this take the breath I could remember, OK, I am here, I’m feeling this. This is the weather. Who is around where I am’.

For score 11 (Fig. 7.15) she created a ‘counter-choreography’ which invites people to perform gestures that bring their attention to their surroundings: ‘I did this score because I forget that whatever I do in my phone, for more personal or intimate [...] is actually getting registered all the time’.

In response to the first score, C3 wrote: ‘...I’ve begun to realize that these data are a part of myself, especially after using gestures to express them. I think I’ve become more aware of online tracking now’. During the interview, she compared the difference between performing small gestures ‘like swipe, save or tap’ and the invitation of scores to involve the ‘whole body’. She mentioned the potential of expressing herself in motion, just ‘like a dance’, and how it allows her to create meaning through movement.

During the interview, she connected tracking ‘online behaviour, such as identifying the clicking searches and interaction patterns’ with choreography: ‘creating dance also involves a range of movements, so they might follow similar patterns’. This idea aligns with the interests of choreography and online tracking to identify discernible patterns, which are introduced in Chapter 1. She added that the scores provide clues on how online tracking operates through body movement and gestures.

Physical enactment of the tracking led to increased awareness of the role of embodiment within online tracking. In addition, bringing bodily experiences to the centre stage supported reflections on online tracking in a way that felt meaningful to the participants.

Physicalising Tracking as a Means of Fostering a Sense of Regained Agency: For most participants, physicalising online tracking became a way of fostering a sense of regained agency towards their use of digital devices and data tracking.

For C1, the feeling of resistance to follow-up occurred in her response to score 5 in which she randomised the gesture of scrolling to confuse the tracking algorithms on Instagram.

During the interview, C2 reflected on how the scores allowed him to pause and reflect on data tracking and, in doing so, regaining agency: ‘Taking us like a step back and kind of just breathing in and getting back into yourself other than like being locked onto your screen, you know it’s like it’s a way that can show you how much control you have over using your devices’. C2

elaborated on the effect of taking a deep breath (score 9) and how it felt a powerful way to disrupt doom scrolling: ‘... sometimes you can be on doom scrolling for hours without looking away, and it only just takes 1 deep breath to kind of be like you’ll snap out of it’. He added that already the physical act of standing up and responding to the scores led him to switch off the internet and disconnect.

Similarly, during her interview, C4 highlighted score 9, noting that the act of breathing brought her attention back to her body. This prompted her to reflect on her actions and intentions, ultimately fostering a sense of regained agency.

C5 connected the dance she created for the final score (no. 12) with freedom to navigate the web without being tracked: ‘Seamless freedom of movement from one webpage to another’.

C3 mentioned during the interview that the score 6 encouraged her to check the pop-up cookies and decline them. She also added that her response to score 11 (see Fig. 7.11) helped her reflect on resisting online tracking through the making of a dance.

The embodied nature of the scores prompted participants to reflect on online tracking, identify points of resistance, and potential ways of regaining agency. As detailed next, participants not only reflected on tracking through physical enactment but also integrated this same approach in devising their counter-choreographies.

7.4.5 Behaviour Change Towards Online Tracking

‘Let’s say no’ - C4 (interview transcript)

All participants reported having changed their behaviour towards online tracking throughout the study. In some cases, the decision to change was prompted by a score; in others, exposure to the study served as the driving force.

This theme describes how the scores elicited both intricate short-term and more sustained user behavioural change towards data extractivist technologies.

C1 reported during the interview being more attentive and taking extra time to read pop-ups about data and privacy. In her response to score 8 (on ‘anti-prediction’), she used randomness to disrupt her usual way of using apps (see Fig. 7.16). In her words: ‘I decided to use an online randomiser to sort the most likely apps I would open. In no particular order, these were YouTube, WhatsApp, Gmail, Google, Facebook, Google Maps, and Spotify. I gave each app a number from 1 to 7. Entered the following into the randomiser 1,2,3,4,5,6,7,1,2,3,4,5,6,7 and hit randomise and kept the first 10 which were 5,1,3,1,6,6,5,2,2,7 and this created a map’.

C3 also used randomisation as a strategy. During the interview, she mentioned that the scores invited her to devise ways to change her behaviour towards tracking, such as taking random actions online. An example is score 5 (on randomisation), which made her realise that changing her usual action on the Chinese app, Little Red Book, from swiping to saving content changed the

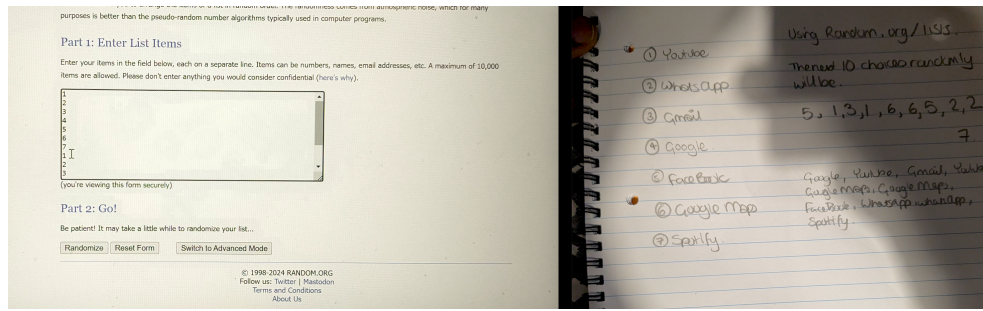


Figure 7.16: Use of an online randomiser in response to score 8, by C1 (2024).

way it fed content back to her. In the interview, she added that she felt that it became harder for the algorithm to determine what her preferences were, and which kind of information was more ‘attractive’ for her. This point came back in her response to score 8, in which she believed random actions chosen may ‘confuse’ predictions by the algorithm. Similarly, C5, in her response to score 8, also highlighted the possibility to ‘confuse the analytics’.

In addition to randomisation, other strategies were implemented, some of which had lasting effects. During the interview, C3 mentioned that she started deleting her browser cookies, and P5 reported that she started to unsubscribe, report spam, and block emails that were targeted and not of interest to her.

C4, during the course of the study, reduced the use of her phone, specifically weather and horoscope apps. This change was reiterated in her response to score 5, where she described substituting familiar gestures with alternatives that disrupted the normal functioning of the app, ultimately leading to diminished interest in the apps and reduced phone use. In her response to score 8, she returned to this thought: ‘I have been checking the weather and the horoscope every morning. This time when I was going to do it I just shut down the phone. Also when I was going randomly to Instagram, I was stopping and being more aware of what has become automatic or mechanical. Then I was trying to use the phone for what it was "really" need it, like email and some WhatsApp messages’.

Most scores focused on prompting reflection on tracking, rather than explicitly asking participants to develop strategies against it. However, score 11, specifically asked participants to create a ‘counter-choreography’ (see Table 7.1). C1’s ‘counter-choreography’ (Fig. 7.17) aims to affect change in people’s engagement and consequentially tracking algorithms: ‘If the score does affect the amount of times that one unlocks the phone, then engagement with the phone and the apps on the phone will also be affected’.

As demonstrated, the participants changed their behaviour towards online tracking, sometimes moving beyond what was being asked of them in response to the daily scores. The next session will zoom in on a particular aspect for which counter-choreographies proved effective: reclaiming time.

Reclaiming Time and Breaking Habits: As reported in Section 7.4.1, C1, C2 and C4 mentioned having grown aware of the time they spent online and its effect on online tracking. Interestingly, they all decided to reclaim their

Score 11

Viral Dancing: Phone Unlock Counter-Choreography!

- Perform 15 Jumping-Jacks every time you unlock your phone.
- How does this make you feel?
- And how does it affect your phone habits?
 - Do you unlock your phone the same number of times or less, or more?
 - Why do you think this is?
- At the end of the day, record a video of you performing 10 Jumping-Jacks.

Figure 7.17: Response to score 11 ('counter-choreography') by C1 (2024)

time back, as one of their efforts in changing their behaviour towards online tracking.

In her interview, C1 mentioned limiting time on apps like Instagram and YouTube as well as hesitating to join TikTok. In her words: 'OK, let's limit it to maybe 2 minutes of scrolling this time and getting out [...] I'm still doing it on YouTube, but I'm trying to like to limit it now'. In a similar vein, C1 wrote in her response to score 4 (on performing gestures at 50% intensity) that it had been the most helpful in reducing the amount of doom scrolling.

C2 mentioned during the interview that the study has made him more aware of the time spent online and the desire to reduce it. Specifically, score 9, on taking a deep breath when scrolling over 75% on a website, as it helped calm the anxiety and rethink his well-being. As he has written: 'The internet and the apps that we use do give us some feeling of anxiety with the amount of things you see per second, so with slowing down and having deep breathes every so often, it can help you reiterate your thoughts and calm your anxiety'. He associated the calming effect of taking a deep breath (score 9) with his decision to install an app that limits app usage (called Opal). During the interview, he added: 'I think it's the amount of time that I'm online is one thing that's definitely like struck out more due to the study. In fact, I got this app called Opal, which is a time tracker out which kind of limits you for each and every app'.

At the end of the study, he felt that he had regained control over his time: 'It's like you're taking back control over your time, your mind as well, your daily tasks, and it definitely does feel as if you know you're in control of what you do every single day'. And consequentially, that he had limited online surveillance: '...also limits the amount of online surveillance that would be imposed on to you if you were using these apps much more often'. He added that he wanted to commit to reducing time online to completely be off any social media in 5 to 10 years.

C4 mentioned during the interview that she wanted to use the phone less and be more aware of her surroundings. As the study evolved, she started saying no to using the phone when she considered it unnecessary. In her response to score 4, she reflected on the relation between 'lowering intensity and time' and consequently reducing online tracking. She reiterated this in score 8, how breaking the habit of using the phone can help reduce tracking. This score heightened her awareness of gestures that had become automatic

or mechanical, enabling her to interrupt unnecessary phone usage. Similarly, score 9 increased self-awareness and connection to her surroundings, leading her to lose interest in her phone and to set it aside. Similarly to C2, during the interview, C4 emphasised how taking a deep breath (score 9) helped her make the conscious decision to stop her online activity. In her words: ‘After taking the breath, I didn’t want to continue, you know, scrolling’.

7.5 Discussion

In this chapter, I illustrate how the *HCCC* scores allowed the study participants to increase awareness of online tracking within their daily lives. As seen in Section 7.4.1, participants have become aware of the prevalence, intrusiveness, and invisibility of data tracking. Some focused on its connection to user interactions, others on how tracking is noticeable through ads and targeted content. Concerns about personal data and the time spent online were also raised. Participants reported that various feelings have emerged during the study (Section 7.4.2) and shared reflections on agency and consent within online tracking (Section 7.4.3). They highlighted the role embodiment played during the study and how physical enactment of tracking supported them in fostering a sense of regained agency (Section 7.4.4). Finally, participants reported behaviour change towards tracking such as by reclaiming time and breaking habits (Section 7.4.5).

This research makes a unique contribution to the HCI community by integrating the creative process of score design with the study of online tracking and examining the impact this has had on study participants.

In the following sections, I discuss the findings and highlight key takeaways. First (Section 7.5.1), I delve into the integration of scores as a daily activity, which proved successful in immersing participants in the reflection of online tracking. This approach allowed for a deeper understanding of how people navigate their online behaviour within their everyday lives. Second (Section 7.5.2), I examine the role that embodiment plays in connecting people’s daily movement patterns with data extraction processes. This enables a more comprehensive exploration than previous studies, shedding light on the intricate relationships between physical activity and digital tracking. Third (Section 7.5.3), I investigate the effectiveness of choreographic scores in exposing data tracking to promote awareness and criticality, leading to user behaviour change. Finally, I evaluate the limitations of my study and outline possible avenues for future research.

7.5.1 Revealing Online Tracking in People’s Daily Routine

‘I’m just more aware of what I do on the Internet now from this study from the past 12 days’. - C2

People are exposed to tracking for each task they perform online daily. Participation in the score study daily emphasised this prevalent character of

tracking in people’s lives.

The participants were able to integrate the scores into their daily routines due to their easy access to their phones. This flexibility allowed them to complete tasks in diverse settings, ranging from commutes to intimate moments such as before falling asleep or immediately after waking up. Thus *HCCC* scores encouraged reflection on online tracking while simultaneously integrating into the digital lives of participants. As detailed in Section 7.2.2, the 12 scores invited participants on a progressive journey, helping them understand different aspects of tracking. The scores were thematically structured to reveal the tracking of the data in relation to the participants’ own digital lifestyle and experiences.

HCCC scores are unique in that they connect to people’s own existing digital ecosystem, while projects such as Data Probes (Taylor et al., 2024) provide purpose-designed objects not previously known to users. Although participants responded to the same 12 scores, these prompts elicited reflection on a variety of distinct digital services. As detailed in Section 7.4, participants focused on different personally significant experiences with the apps and websites they used.

This study allowed for a more in-depth reflection on how people were involved in online tracking that previous studies did not allow. In the *HCCC* performance (Chapter 5), I demonstrated tracking by navigating through multiple websites, starting with the Google search engine. I explicitly selected a range of well-known websites that people could identify; these were ultimately my choice and not tailored to each person’s online consumption. During workshops (Chapter 6), most groups focused on an app or online service that was familiar to all members. Although this is a step closer to the *HCCC* scores, it did not allow people to reflect on the range of apps they use daily and dive deeper into issues related to online tracking.

The *HCCC* scores evoked varied responses from each participant, some of which were more personally resonant and even emotionally impactful (see Section 7.4.2). Participants reported less positive feelings, such as anxiety and vulnerability; there were also positive ones, such as peace and freedom. Although GDPR defines sensitive data as a subcategory of personal data, users’ perception of what data counts as ‘sensitive’ varies (Gómez Ortega et al., 2023). The scores allowed participants to make sense of what is important to them when it comes to data tracking, how they actually feel about it, and their desire to protect their privacy (see 7.4.3).

The scores were also a playful and lightweight approach to engaging in a seemingly complex topic. This was explicitly noted by C1, C3, and C5, who mentioned that the scores encouraged them to participate in creative activities that they would not usually have explored. Responding to daily scores can be demanding, but the creative and playful character of the scores motivated people to continue to engage throughout the study.

Thus, the integration of scores as a daily activity proved successful in immersing people in the reflection of online tracking in their daily lives. Next, I will discuss the role that embodiment played in this process.

7.5.2 Connecting People’s Daily Movement Patterns with Online Tracking

‘...when I use my body to express this kind of process, then it just brings my awareness about what really happened. Makes me know the importance of protecting my privacy’. - C3

The *HCCC* scores invited the study participants to connect their daily movement patterns with the data extraction process.

The scores encouraged participants to perform physical tasks, sometimes embodying tracking concepts, such as clapping or drawing, away from devices. Other times, scores prompted proximity to gestures performed online, such as scrolling or clicking, highlighting their connection to data tracking. The embodied and choreographic approach of the *HCCC* scores allowed participants to connect daily gestures and actions offline with those online and vice versa, reflecting on the permeability of those. The participants weaved these experiences as they made sense of data tracking.

Some scores were designed to prescribe specific movement sequences, while others were kept open to interpretation (see 7.2.2). This allowed people to find their own embodied expression and personal choice of movement sequences. The flesh became the score — through which the ‘counter-choreographies’ were interpreted, transmitted, embodied, and performed. Participants explored new connections between movement of different scales, from small gestures on their devices to larger full-bodied experiences. The process also allowed people to notice existing movement patterns imprinted in their bodies and how they were related to tracking.

Within the group of five participants, one had a background in dance (see 7.3.1), which may have influenced her involvement in the choreographic elements of the study. However, the notable aspect of the participation of this participant was not the ease of performance but the complexity and expressiveness of her movements. For example, this participant engaged with a larger portfolio of movements and created more intricate movement sequences. However, the reflections on the data tracking were not different from those of other participants.

Generally, engaging with their bodies ‘in motion’ enabled participants to reflect on online tracking in novel and empowering ways (see 7.4.4). Building on approaches like the Digital Defence Playbook (ODB, 2019), which facilitates reflection on the relationship between data and bodies through workshops, the *HCCC* scores further integrate embodied practice by incorporating physical movement. Furthermore, *HCCC* extends this by encouraging participants to engage in these tasks throughout their daily lives – often within the familiar context of their homes. This work contributes to a wider exploration of integrating physical tasks and gestures into everyday routines of people, thus broadening the scope of the exploration of embodied data beyond structured workshop settings.

Previous studies (Chapters 5 and 7) prompted participants to reflect on data extraction and its impact on their daily lives through choreography and embodiment. Although the time span of those studies did not allow participants to deeply explore the role bodies play in the process of reflecting upon tracking and in enabling forms of emancipation.

The *HCCC* scores invited people to find meaning through choreography and allowed them to reflect on the tracking in an embodied way. It also inspired participants to create their own strategies to counter online tracking, which is discussed next.

7.5.3 Counter-Choreographies of One's Own

‘[the scores] give me so many clues to explore on my own.’ - C3

As mentioned at the beginning of this chapter (see Section 7.1), the first objective of the scores was to raise awareness and critical reflection of data tracking. Secondly, to explore how daily engagement with the scores could lead to participants behavioural change. Participants underwent this process by initially discovering habitual patterns in how they interacted with their digital environment and, subsequently, breaking these patterns.

Beyond completing the 12 choreographic scores, the participants altered their behaviour and actively sought to regain their agency towards their use of digital devices and data tracking. (see Section 7.4.5). *HCCC* prompted people to critically reflect on online tracking and create their own counter-choreographies in response to that. Participants' counter-choreographies ranged from randomising user interactions to deleting browser cookies or unsubscribing and blocking emails. Each participant prioritised what felt most relevant to them in changing how they usually use apps and interact online.

A common thread among the participants was the desire to regain their time and break the habits related to online engagement. The latter is intrinsically connected to the way algorithms operate to grow engagement metrics that feed the attention economy (Williams, 2018). The longer users spend interacting with content online, the more likely algorithms are to effectively target them. *HCCC* supported participants in reflecting on their entanglement with tracking algorithms in their day-to-day lives and finding ways to disentangle.

HCCC aligns with the work of Andersen and Wakkary, which encourages participants to playfully and critically examine their concerns and assumptions about technologies. In addition, it encourages individual participants to explore their agency and control over the narratives they engage with (K. Andersen and Wakkary, 2019). My approach in problematising data extraction through choreographic scores and a sense of embodied engagement enabled personal visions of participants to come to the surface. The *HCCC* scores were designed as a starting point for people to develop their own strategies to cope with the tracking of data in their lives. Like dance scores, *HCCC* scores are open to interpretation and modification.

The scores allowed people to experience their own data, reflect on their own daily choreographies, and create their own counter-choreographies.

My work also complements projects such as *The Voices and Voids* (Desjardins, Psarra et al., 2021) by inviting people to incorporate the scores into their lives, create their own responses to the scores and their own scores. *HCCC* invites people to build a connection between daily patterns imprinted in their bodies and their connection with data extraction. The way people made these connections was varied; there was no ‘correct’ way to respond to the scores, it is a personal endeavour. In fact, the participants highlighted how the scores allowed them to subjectively engage in data tracking in their daily lives.

Previous studies (Chapters 5) and 6) lacked the level of personalisation and insight into the effect of this research on people’s lives that the scores allowed. The *HCCC* scores and the study delved deeply into the concept of counter-choreographies and how the participants found meaning in them.

Despite a general lack of awareness, online tracking has become embedded in the daily lives of people. The scores prompted critical reflection on this integration and encouraged the development of counter-choreographies, which subsequently became integrated into the routines of the participants. *HCCC* contributes to HCI by demonstrating the effectiveness of using choreographic scores to expose data tracking to promote people’s awareness, criticality, and lead to behavioural change.

7.5.4 Limitations and Future Work

As noted in Section 7.3.1, the small sample size of this study was a deliberate choice to allow a detailed investigation of its effects. However, a larger group of participants would allow for comparison of perspectives in different demographics and a better understanding of commonalities and differences in people’s experiences with scores.

Furthermore, the study of *HCCC* scores was limited to two weeks, without follow-up with participants to learn about the effects of the study in the following months. I see a potential for our approach to be adapted to a longer timespan and complemented with ‘check-in’ interviews to understand how long participants have continued the efforts to resist tracking, or if they devised new counter-choreographies.

This study provided a platform for people to reflect on data extraction in their daily lives. Intentionally, I did not direct people to adopt alternative habits or tools to prevent tracking. Instead, I wanted to make it possible for them to create their personalised solutions. During the interview, C2 commented that he had learnt different aspects of online tracking and his desire to know more: ‘I’ve seen like different aspects of the way people can be tracked from the movements that they have online, but I think I need to still learn quite a bit more about, you know, how and why’. In response to this, in the public version of the *HCCC* website (see next Chapter’s section 8.3), there is a new page with resources to learn more about data tracking and examples of privacy-enabling technologies.

This study investigated the general usage of digital services, which provided a holistic perspective on people’s reflection and their awareness of data extraction in their lives. I see opportunities to explore the use of daily scores to raise awareness of extractivist technologies beyond the private sphere. For example, in the context of the workplace (Popova et al., 2024). The *HCCC* approach can be expanded to incorporate issues related to labour rights and inspire alternative structures of cooperation and solidarity. As Bonini and Treré identify, workers in the gig economy have been inventing and adopting tactics to bypass and resist algorithmic surveillance (Bonini and Treré, 2024). *HCCC* can be expanded beyond individual performance to forms of collective solidarity (Chicau et al., 2024). The 12 scores can be adapted to groups of people to reflect on the implications of data tracking on a digital platform common to all. The concept of counter-choreographies has the potential to enable collective action against technological platforms and algorithmic power. This is further elaborated on in the final chapters (see Section 9.2).

7.6 Conclusion

This chapter examines an artistic research project that bridges choreography and data tracking. It details the design of the Human-Computer Counter-Choreographies website, which features 12 scores that expose various facets of online tracking. The study involved five participants over two weeks and demonstrated that engaging with the scores improved awareness and reflection on agency with respect to tracking, prompted behavioural changes, and emphasised the value of bodily involvement.

This research contributes to HCI in two ways: (1) provides design insight into creating an interactive web platform that raises awareness about data tracking, featuring 12 scores that prompt users to reflect on their own behaviour; (2) supports these insights with empirical evidence that demonstrates the effectiveness of this approach, including its ability to raise critical awareness and lead to changes in user behaviour regarding online tracking.

This chapter concludes with a discussion of the study’s contributions, offering valuable perspectives for research on data surveillance within HCI.

The next chapter 8 details an exhibition of the *HCCC* scores designed to expand outreach and engage a wider audience. This exhibition features a revised version of the *HCCC* scores and website, incorporating a growing collection of counter-choreographies, including contributions from participants in this study.

Chapter 8

Exhibition

8.1 Introduction

This chapter details the public-facing version of the *Human-Computer Counter-Choreographies* (HCCC) website, developed to expand access to the work introduced in Chapter 7. First, I outline the process of redesigning the HCCC scores and the website that exposes different aspects of online tracking in people’s daily lives. Secondly, I describe the production of printouts and video material shown in a public exhibition presented at the NewBridge Gallery in Newcastle, the UK. Finally, I reflect on the process of making the HCCC scores and the website public and future work.

8.2 Methodology

8.2.1 Artistic Research

As introduced earlier (see Chapter 3), this project is part of a larger body of work that follows an artistic research methodology (Borgdorff, 2010) that bridges choreography with online tracking algorithms. My work follows a lineage of HCI methodologies that emphasise the generative and creative potential of embodiment and physical movement (see Section 2.2.2).

In this vein, I present my artistic research based on an autobiographical process that led me to redesign and make public the HCCC website that displays a collection of choreographic scores to reveal online tracking to users. The website and exhibition materials (see Section 8.3.1), exposed data tracking techniques and asked users and audiences to critically reflect on the prevalence and evasiveness of such algorithms. My aim was to make abstract concepts related to data tracking more tangible by inviting people to perform choreographic scores that allow them to critically reflect on the mechanisms of data tracking online.

8.3 Scores Collection: Making Public

Following the design and study described previously (see Chapter 7), I designed a public version of the Human-Computer Counter-Choreographies web-

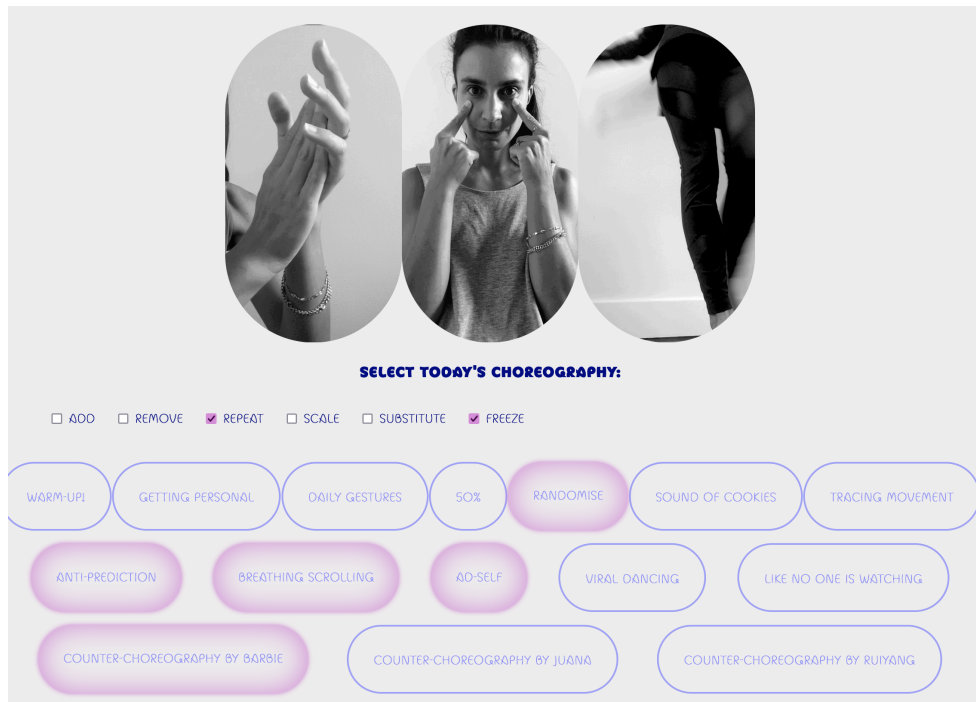


Figure 8.1: Screenshot of the landing page showing the sequence of animated GIFs and scores index (2025).

site ¹. The *HCCC* website was launched at the exhibition *The Everyday Algorithms* (described in Section 8.3.3) as a first step to make this work accessible to the general public.

8.3.1 Interface Redesign

As mentioned in Chapter 7, the score website built for the previous study proved to be playful and easy to navigate. For this reason, I kept the same layout and structure, with minor adjustments and content additions.

Starting at the top of the landing page, I added a sequence of animated GIFs showing me performing the scores to illustrate how people might engage with the content of the website (see Fig. 8.1).

Scrolling past the GIFs, the 12 scores are displayed (see Fig. 8.1), and each of them has a dedicated webpage. The scores are categorised following the choreographic vocabulary: 'repeat', 'substitute', 'freeze', 'remove', 'add', 'scale' and 'randomise'. This vocabulary was originally created for performances (Chapter 5) and workshops (Chapter 6) as part of the choreographic prompts that favoured daily gestures that are easy to understand and respond to. This is in line with the work previously referenced (Boal, 2019; Wood, 2007) that prioritised mundane, 'day-to-day' movements over movement intricacy. In workshops, the same vocabulary was used to generate ideas for resisting and counteracting online tracking on the online service chosen by the participants (see Chapter 6).

I included three pages of three participants in the study previously conducted (Chapter 7) who volunteered to share their counter-choreographies (score 12); see example Fig. 8.2. Similarly to animated GIFs, these examples show

¹Available at: <https://joana.art/counter-choreographies>

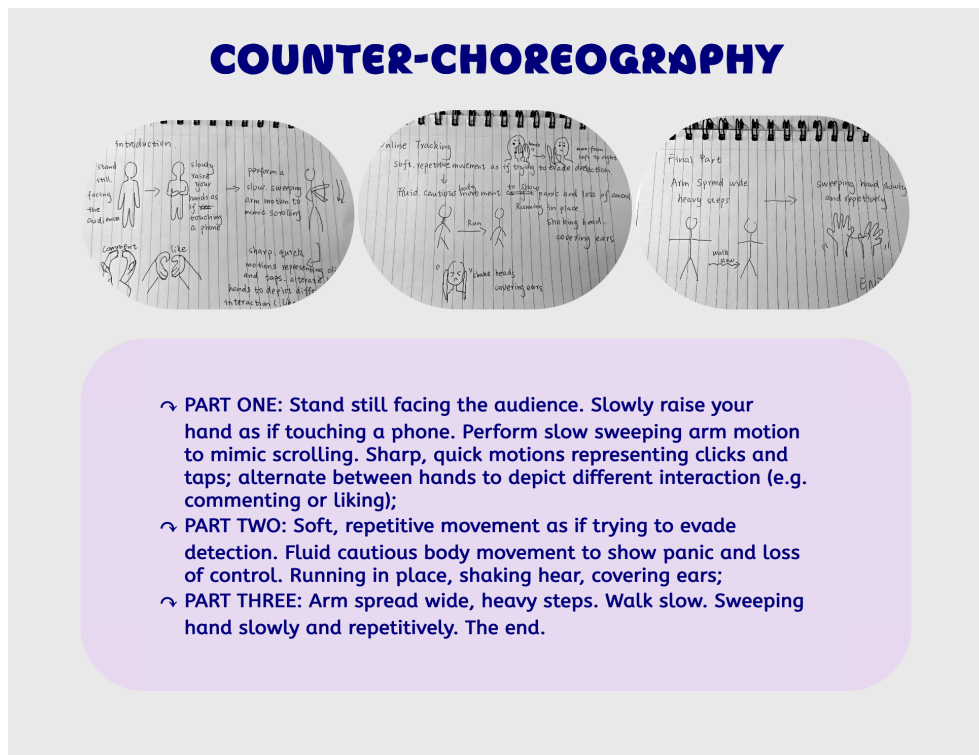


Figure 8.2: Counter-Choreography by study participant (2025).

how diverse the responses to the same idea of counter-choreography can be (Folkerts, 2016).

Finally, I added two links to the bottom of the landing page, one for the ‘About’ page that introduces and contextualises the project. The second, on ‘Inspiration and Resources’ that provides information on privacy-enabling technologies (PETs) and links to practical guides on data protection. This information adds to the 12 scores which do not rely on external technologies. Instead they raise awareness of different aspects of online tracking and prompt behaviour change towards it in ways that are related to people’s routines (see Chapter 7). This page complements those efforts by listing options for choosing PETs.

8.3.2 Materials for the Exhibition

As part of the exhibition display, a series of scores was printed in both large and small formats. For the small prints (Fig. 8.3), I redesigned a selection of scores (numbers 4, 6, 10, 11) to allow people to write their reflections, take them home, or leave them, and contribute to the exhibition material if they wished.

Finally, I recorded myself performing the scores ² to illustrate how each score can be interpreted and embodied (Fig. 8.4). Over the course of 12 days (in August 2024), I recorded videos of myself performing the scores, creating a physical imprint on my body as I responded to each score each day. This process allowed me to reflect on my first-hand experience of performing the scores. It made me relate more intimately to the scores and questions I was

² Available at: <https://ualresearchonline.arts.ac.uk/id/eprint/24369> (Accessed August 2025).



Figure 8.3: Printouts of the Score at the exhibition (2025). Credit: Matt Denham.



Figure 8.4: Video projection of myself performing the 12 scores at the exhibition Everyday Algorithms (2025). Credit: Matt Denham.

posing to my audience and users. This experience led me to revise the initial scores, together with the feedback from the participants of the previous study (see Chapter 7).

The video combines snippets of me performing movement sequences (scores 1,2, 3, 6, 9, 12), re-enactment of interactions with devices (scores 4 and 5), writing and drawing (scores 7, 8, 10, 11). The video is mostly silent, except for instances in which I voice personal data (scores 1 and 2) or the sound of clapping (score 6). The video duration is approximately 6 minutes.

Creating materials for the exhibition prompted me to explore different ways to engage audiences with the work. I designed a variety of access points, including printed scores –intended to provide a quick entry point before visitors explore the full collection on the website – and the video overview that offered a more in-depth experience.

8.3.3 Exhibiting *HCCC*

The Everyday Algorithms exhibition ³ (21 February - 17 April 2025), curated by Shelly Knotts at the NewBridge Gallery, highlighted the active role humans play in creating code and designing algorithms and data structures. It focused on under-recognised narratives within this field. The artworks showed how algorithms can be used to support human needs for care, community building, and autonomy.

As people enter the gallery space, they first encounter the video projection, as it is the most prominent piece in the exhibition space. The sound of the video was played on speakers and could be heard anywhere in the gallery, emphasising the pervasiveness of data tracking. The video was played in a loop, highlighting the cyclical and repetitive character of daily gestures and data extraction processes. I chose to combine the recordings of me performing with screenshots from the corresponding scores page within the same video. This allowed visitors to make a connection between the video, the printouts, and the website displayed in the exhibition space.

Unlike previous formats – performances (Chapter 5) and workshops (Chapter 6) - the exhibition required a change in how I communicated my work, as I was no longer present to directly facilitate. For this reason, I produced stand-alone materials, such as the website, video, and printouts, which the audience explored at their own pace. For example, a QR code with a link to the website was included in the printed copies and displayed next to the video projection. Furthermore, as mentioned in Section 8.3.1, the website includes a page that introduces the project, reiterating and complementing the information provided in the exhibition space.

The *HCCC* website was launched at the exhibition to make it accessible to a wider public. The process of creating the materials for the exhibition allowed me to explore different possibilities to communicate the work. From more immediate provocations, such as the printed version of the scores, in which people might start by first engaging with one score and then visit the website

³More information at: <https://thenewbridgeproject.com/events/everyday-algorithms/> (Accessed December 2025).

to experience the whole collection. Alternatively, a slightly longer encounter, such as the video, provides an overview of the scores. These different modes allow for a gradual in-depth engagement with the project, within the gallery space and outside of it, if visitors wish to continue engaging with the website.

8.4 Discussion

8.4.1 Insights from an Artistic Research

Artistic Research (Borgdorff, 2010) is a method that gives space to the artist's voice. *HCCC* is an artistic research project (as detailed in Section 3.2.1), deeply grounded in my choreographic practice. The choreographic references that influence *HCCC* reflect my interests and dance trajectory. For example, the notion of choreography as a practice of inquiry into daily life shaped *HCCC* at conceptual, technical, and aesthetic levels (see Section 2.2). Another example is the choice of an online platform that reflects my practice in making browser-based artworks (as detailed in Section 1.1). Undoubtedly, my background and experiences shaped these design choices. However, I also offer larger insights that come from an authentic and reflexive understanding of these choices in my own process as an author preparing the exhibited artistic materials (as described in Section 8.3).

HCCC complements projects such as the *Data Detox* (Tactical Tech, 2016a) and *My Shadow* (Tactical Tech, 2016b), in centring people's bodies and daily routines while raising awareness of issues around data tracking specific to their usage of apps and digital services. *HCCC* also adds to computational artworks such as *Score for Performing User* (Lee McCarthy, 2022) by allowing people to incorporate scores into their daily lives and create their own scores.

HCCC invites people to build a connection between daily patterns imprinted in their bodies and the extraction of data. The way people make these connections is varied; there is no predetermined or correct response to the scores. Like other dance scores, these are open to interpretation, incorporation, and modification by whoever performs them (Folkerts, 2016). However, it is important to acknowledge that, despite the openness of the scores, they are not neutral—they reflect the artist's own interests. Drawing on Bishop's critique of spectatorship politics (Bishop, 2012), *HCCC* establishes a hierarchy: the artist frames online tracking and choreography, while the audience is conditioned to experience this point of view. The project invites participation on-site for those who wish to respond to the scores; however, viewers do not need to perform the scores to understand how they work; they can watch the artist's video and the project documentation. They can also choose to revisit the website later and engage with the scores privately, without sending any data back to the artist.

The *HCCC* scores enact between bodies and technologies ingrained in our routines. The score collection and the website complement previous work in that it makes material publicly available beyond the confines of performances (Chapter 5) and workshops (Chapter 6). Exhibiting *HCCC* furthered my objectives in presenting choreographic scores as a creative and engaging

method to expose data tracking to a larger audience and inspire new counter-choreographies.

The *HCCC* scores were designed as a catalyst for people to develop their own coping strategies in response to data tracking. In contrast to Chapter 7, which involved collecting data from study participants, the exhibition did not include any follow-up interactions with visitors. As a result, there is no way to assess whether attendees engaged with the scores and, if so, how. To address this limitation, adjustments could be made, such as dedicating a specific area in the exhibition space to display the scores or providing a direct upload link to the platform. In addition, interactive activities can be integrated into exhibitions to foster direct engagement between visitors and scores.

8.4.2 Future Work

The score collection and website breathe life into *HCCC*'s work, inviting audiences to engage with, interpret, and perform the scores. Furthermore, these scores can transcend traditional audience interactions, inspiring artists to re-appropriate or adapt them in their own creative endeavours, or even utilising them as thought-provoking teaching tools.

I intend to expand *HCCC*'s work through both online and in-person presentations, further growing the collection of counter-choreographies. Future initiatives to promote the online platform will focus on expanding its reach to a broader audience, thereby increasing awareness and fostering critical examinations of surveillance capitalism (Zuboff, 2015) and the pervasive influence of data extractivism in our societies.

8.5 Conclusion

This chapter details the act of making public the Human-Computer Counter-Choreographies website, which features 12 scores that expose various facets of online tracking. It provides a reflective account of the redesign of the scores collection and new exhibition materials that aim to increase awareness and agency regarding online tracking through bodily involvement. I illustrated how the public version of the scores website guides people in questioning, re-evaluating and countering everyday routines and movement patterns concerning data extraction. This chapter concludes with a discussion of the conceptual approach of the work, which offers valuable perspectives for research on data surveillance within the computational arts.

Chapter 9

Reflections

‘Resistances to algorithmic practices require practices of resistance that reconfigure what algorithms should or could be’ – Benjamin, 2022, p 5.

9.1 Investigating the Potential of Counter-Choreographic Practices

This chapter reflects on the research process and outcomes that constitute *Human-Computer Counter-Choreographies*. Throughout this thesis, the concept of ‘counter-choreographies’ serves as a unifying thread. Counter-Choreographies connect with a lineage of works that invite critical and creative engagements with data as a cultural, social and political medium. In doing so, they aim to inspire the re-imagining of algorithmic practices (see Section 2.5). Counter-choreographies contribute to these efforts by raising awareness and providing evidence of behavioural change among study participants in relation to tracking — rather than by exercising explicit control or technical intervention over how such systems operate. They raise critical awareness of tracking algorithms in peoples’ lives by prioritising processes that involve physicalising of online tracking. In this context, bodies become integral to the process, allowing more intimate and visceral forms of resistance to emerge. Counter-choreographies is a novel approach to challenging data extraction through embodied engagement, fostering awareness and critical reflection that lead to user behavioural change.

This concept inspired this research, which began with the following question:

- RQ1: What is a choreographic approach to countering data extraction in the context of human-computer interaction and computational arts?

To facilitate a more focused investigation, two additional research questions were formulated, focusing on online tracking algorithms:

- RQ2: How can this choreographic approach increase awareness of and reflection on online tracking in people’s lives?

- RQ3: How can this new approach inspire forms of raising awareness that lead to user behavioural change?

These questions guided a practice-based research that included the creation of a custom browser extension (Chapter 4); a new live-coding performance piece that combines choreography with online tracking (Chapter 5); a new workshop approach to raise critical awareness of data tracking through an embodied choreographic approach (Chapter 6); and a web-based platform featuring a collection of 12 scores that invite visitors to reflect on data tracking in their daily lives (Chapter 7). Throughout this thesis, I present each artistic work alongside the insights from my research and design practice which informed its development process and results (Section 1.4). I also share empirical data demonstrating the effectiveness of my work in provoking participants to critically examine online tracking and in prompting behavioural change towards such extractive algorithmic systems.

As the title of this thesis suggests, the motivation of this research was to improve users' awareness and empowerment in relation to online tracking algorithms. Empowerment takes many forms such as in enabling people to critique online tracking algorithms in their daily use of digital platforms in an embodied way (Chapters 5, 6 and 7); and in leading to behaviour change in relation to online tracking (Chapter 7). Moreover, the concept of counter-choreographies acts as a provocation for other forms of empowerment yet to be realised (Section 9.2).

The following Sections 9.1.1, 9.1.2, and 9.1.3 present the main findings of each research activity, tracing how each step advanced the investigation, and how the challenges encountered were addressed along the way. The work described also yielded new research pathways and questions, which are summarised in Section 9.2.

9.1.1 Insights Gained from Artistic Research

Informed by Artistic Research methodologies (Borgdorff, 2010), *HCCC* presents a series of works that explored a 'choreographic approach to counter data extraction in everyday life' (RQ1). As detailed in Chapter 3, the artistic and design choices were shaped by my trajectory in dance and my practice as a live coder and critically engaged artist. Consequently, *HCCC* is deeply rooted in my artistic practice, which defined the scope of the project and the communities I engaged with.

The artistic research process was porous and the different works interconnected. Starting with the work on the browser extension, it builds on my interest in web technologies (see Section 1.1). For this reason, I started my investigation of online tracking by engaging directly with native web tools as described in Section 4.3.1. The browser extension was then used as part of the subsequent work (see Chapter 5 and Chapter 6). Additionally, the programming scripts developed for the performance piece were adapted to the scores collection website (see Section 7.2.3)

In a similar vein, choreography is an overarching element that binds together the different works. My choice of choreographic references came mainly from the postmodern dance period (see Section 2.2). The nature of these choreographic works, which embrace ordinary movements such as walking, provided an easy entry for the study participants. My empirical results show that the participants were receptive to the choreographic approach, even though the majority of the participants were not familiar with choreography or dance. Indeed, the participants appropriated the choreographic vocabulary as it helped them express their thoughts about data tracking (see, e.g., Section 6.5.1).

HCCC contributes to discourses that expand conceptions of choreography beyond traditional dance-making (Klien et al., 2008; Leon, 2022; Spångberg, 2012) to encompass critical reflections on how movement regulation is enacted more broadly in society (Egert, 2022; Lepecki, 2015). In future work, I would like to build collaborations that explore how other forms of dance expression, and choreographic methods, may contribute to the growing critical awareness of surveillance capitalism.

In addition to designing embodied and choreographic activities, I witnessed and assessed how people responded to performances and workshops. In addition, I performed the 12 scores myself (see Section 8.3.2), gaining a deeper understanding of how they worked. This aspect of first-person involvement allowed me to remain immersed in the artistic process and reflect on it in an embodied sense.

Making sense of algorithms and data-driven systems, including online tracking, is an ongoing challenge, as these algorithms are largely inaccessible, highly variable across platforms, and rapidly evolving (Kitchin, 2017). The work to support and empower users is an ongoing effort as presented in Section 2.5. It emphasises first-person methodologies and embodied experiences that have gained interest from HCI communities (Loke and Schiphorst, 2018). *HCCC* holds potential to expand the understanding of artistic research by HCI researchers through creative experimentation, interdisciplinary integration, and public engagement. This thesis offers insights from an authentic and reflexive understanding of these decisions.

The next two sections reflect on the effectiveness of research activities as both critical and thought-provoking (Section 9.1.2) and physically engaging (Section 9.1.3). My design process, empirical results, and discussion provide concrete lessons that can inspire new design directions beyond my specific use and that artists and HCI researchers can take forward (see Section 9.2).

9.1.2 Growing Awareness of Data Tracking

My second research question (RQ2) asked how choreographic approaches could support people in increasing their awareness of and reflecting on online tracking. The choreographic approach was purposely developed to reveal, critique, and challenge data extraction technologies. It did so by initially exposing the concerns people had about the technology with which they interacted. Subsequently, it enabled them to envision other possibilities for the use of these technologies and address their concerns (see Section 9.1.3).

The findings in all research activities demonstrate that the embodied and choreographic approach increased the awareness of the data tracking of participants, including its prevalence, intrusiveness, and invisibility. However, differences were observed in the specific mechanisms by which each work stimulated reflection.

Performances and workshops exposed participants to tracking algorithms through two primary methods: literal visualisation of tracking data through the custom web extension (see Chapter 4) and the choreographic approach (see Section 3.2.3). In contrast, the study using scores allowed a more nuanced understanding of which specific aspects of the online tracking participants became aware of. This is attributable to the deliberate focus of the scores on the relationship between tracking and user interactions, the influence on advertising and targeted content, and the volume of personal data exchanged.

Performances and workshops prompted participants to reflect on the powerlessness and insidious lack of agency inherent in digital services and the extraction of their data. In contrast, the scores placed less emphasis on these feelings of powerlessness, probably because the structure of the study facilitated a shift from reflection towards the development of practical daily actions to counter the tracking and enhance the sense of control of participants over their online behaviour.

Since the beginning of my PhD research in 2022, the issue of data tracking has been significantly amplified by Generative AI (GenAI). Users are increasingly vulnerable to sophisticated manipulation through personalised ad content and finely tuned targeting powered by GenAI, using the data they provide (Dent, 2025). Despite advances in algorithmic capabilities, the core revenue model for major web platforms remains ad targeting. For example, since launching its first advertising product in 2004, Meta has consistently relied on advertising revenue to support its business, generating nearly \$70 billion in profit from \$165 billion in revenue in 2024 (Dixon, 2025). This revenue stream enables Meta to offer its social networks and messaging products free to users, although at the cost of their data (Wells, 2025). Recently, Meta's Advantage+ tools exemplify advances in AI-powered advertising, using data from its platforms, Facebook and Instagram, to optimise ad delivery (Meta, 2025). These tools promise to 'automatically show ads to people most likely to respond' by continuously learning from user interactions with ads both on- and off-site (Meta, n.d.). Consequently, the continued reliance on ad targeting provides limited incentive for companies like Meta to change their data extraction practices, highlighting the need for further research and intervention in this area.

9.1.3 Bodies as Site of Resistance

This section continues to expand on the second research (RQ2) question by exploring the relationship between embodiment and increased awareness of online tracking. In addition, it addresses the third research question (RQ3) by investigating ways to inspire user behavioural changes towards data-extractive technologies.

Unlike other forms of challenging data-extractivist technologies, *HCCC* centred embodied experiences within this process (see the Performance’s section 5.4.1, Workshops’ section 6.4.3, and Scores’ section 7.4.4). Bodies themselves became an integral part of the resistance process against tracking, particularly in the creation of counter-choreographies. The involvement of their bodies supported the participants in making abstract and technical ideas around data tracking more tangible. Furthermore, the choreographic and embodied approach revealed how data tracking was integrated and connected to their physical selves. It also allowed more intimate and personal resistance processes to emerge.

Due to the nature of each research activity, different approaches were developed to physically engage the participants. Each research activity represented a step further in designing formats that enabled people to create their own counter-choreographies.

Beginning with the browser extension — which visualised and sonified tracking requests — I first sought to provide a sensorial experience of how pervasive tracking is (see Section 5.2.4).

The performance piece then prompted audience members to embody tracking algorithms, fostering a deeper and more meaningful connection to the topic (see Section 5.2.4). Although the concept of counter-choreographies was not explicitly addressed in the performance, it served as an invitation for audience members to take further steps in resisting or countering online tracking.

In the workshop, participants were explicitly asked to devise their own counter-choreographies. These activities supported participants in imagining strategies to disrupt online tracking algorithms and challenge the constraints imposed by the services they analysed (see Section 6.2.3). A key difference between the workshop and other activities was the group dynamic, which enabled people to combine multiple perspectives. This aspect potentially fosters a shift from individual to collective action, as discussed in further detail in Section 9.2). The workshop also allowed me to investigate participation and consensus-building within group exercises and collective discussions, while the performance allowed me to connect with a larger audience and develop tactics to communicate in that specific setting through live code.

The scores facilitated the most in-depth involvement of people’s bodies through the physicalisation of the online tracking. Each score suggested different ways to move and draw connections with personal data tracking (see Section 7.2.2). Because the study was conducted over a longer period, participants had the opportunity to explore more possibilities of movement and connect aspects of tracking to their daily lives. Their reflections were contextual, relating to specific instances from their daily routines. Moreover, they engaged with a wider range of movements, expanding on their self-expression (see Section 7.4.2). In particular, the participants were more emotionally involved (see Section 7.4.4); they described a multitude of feelings triggered by the process, an aspect not explicitly mentioned in the other research activities. Furthermore, the score study was unique in that participants reported changes in their behaviour towards tracking. This is a promising avenue for

future work, as discussed in Section 9.2.

The design of the research activities progressed from a more prescribed approach in the performances, to inviting participant contribution in the workshops, and culminating in the most open and generative format with the scores. Specifically, the final set of scores invited participants to take the lead and create their own counter-choreographies. Although the scores appear to have been the most successful in deepening the embodied engagement of the participants, they also require a greater commitment of time from the participants, which may not always be feasible. Consequently, each format allows individuals to engage in different settings and time constraints.

Countering data extractivism, in the context of this work, is rooted in choreographic practice and in an understanding of bodies as sites of resistance. *HCCC* complements existing strategies for resisting data extractivism and techno-solutionism by raising critical awareness and inspiring behavioural change towards data-extractive technologies. It empowers individuals to build resilience in their relationship with technology. This might inspire existing methods that bridge performance and theatre practices with algorithmic awareness (e.g. Backhouse et al., 2023; Jones et al., 2023; Skirpan et al., 2018) to engage participants in explicitly reflecting on the norms embedded within algorithmic systems.

HCCC extends existing epistemologies and methodologies that involve bodies in HCI by including their political and critical dimensions (Tsaknaki et al., 2025). Feminist scholars have examined bodies through the lens of the diverse experiences that these meanings generate (Federici, 2004; Wendell, 2013). Although I do not frame my approach as Feminist per se, I argue that my work embodies the feminist values described by Bardzell (S. Bardzell, 2010): pluralism, participation, advocacy, ecology, self-disclosure and embodiment. Specifically, I took great care to invite participants from diverse cultural backgrounds, bringing a plurality of perspectives that help to avoid homogenisation or totalising views on the topics. The involvement of participants in and post-activities continued conversations led to forms of advocacy and distribution of authority within the development of the larger body of work. It also embraced a holistic and ecological standpoint that reflects on context and relationality: ‘the ways that design artefacts in-the-world reflexively design us’ (S. Bardzell, 2010, p. 1307). The feminist value of self-disclosure was reflected in the first activity, the browser extension that visualised and sonified tracking requests, allowing me to make visible how tracking algorithms ‘effects us as subjects’ (S. Bardzell, 2010, p. 1307). This power imbalance between users and the digital systems they use was recurrent in participant reflections and served as the basis for the counter-choreographies that they created. Finally, in line with S. Bardzell’s values, embodiment was at the core of my research. I centred the experience of data tracking on bodies by inviting participants in movement activities and in designing counter-choreographies to online tracking. Thus, while I do not qualify my approach as Feminist per se, mixing critical and embodied methods led me to propose an approach that aims towards the same goals as feminist HCI – namely, resisting the status quo and proposing action-

able alternatives to oppressive mechanisms found in computational systems such as surveillance capitalism (Zuboff, 2015).

9.2 Future Work

My approach certainly presents limitations. I see these limitations as opening opportunities for future work. The main limitations concern the duration of the studies and the greater outreach of the audience and participants. For my own practice, future work can consider a longer-term commitment with participants to learn about the lasting effects of the counter-choreographies. In addition, efforts to open up to other audiences have already been initiated, as demonstrated by publishing the *HCCC* website and presenting it in an exhibition (Chapter 8). Continued outreach will open up the possibility to engage more people in the awareness of data tracking.

Next, I expand on other opportunities for artists and HCI researchers within which the choreographic approach and the concept of ‘counter-choreographies’ can play a role.

9.2.1 Counter-Choreographies: Expanding Applications

Data extractivist technologies are part of a wider process of global extractivism that reveals the underlying drivers and dynamics shaping our contemporary societies (Chagnon et al., 2022). *HCCC* offers an approach that can strengthen and energise existing movements resisting data extractivism and techno-solutionism. Through a choreographic approach, it can help individuals cultivate more resilient relationships with technologies. This, in turn, can facilitate collective efforts to acknowledge historical injustices and strategies to resist and mobilise for systemic accountability (J. W. Gray, 2025).

Building on my earlier discussion of counter-choreographies as a means of resisting data extractivism, I now turn my attention to exploring how this approach might be extended to address other facets of data tracking and algorithmic surveillance. I highlight three main threads: the first is to investigate data extractivism and user autonomy (or lack thereof) in the context of the quantified self-movement. The second is a shift in the focus of ‘counter-choreographies’ from individual to collective action, in particular as a form of reflection on the role of extractive technologies in the workplace. Finally, *HCCC* can contribute to research on algorithmic literacy to address the lack of transparency, bias, and discrimination, including raising awareness of the environmental impact of digital products.

Biodata and Self-Sensing: *HCCC* sought to engage people in making connections between their daily use of digital services and online tracking. Future work can explore how online tracking operates on platforms of a specific domain or category. For example, an area where data capture has been problematised is the quantified self movement (also known as ‘personal informatics’, ‘self-surveillance’, ‘self-tracking’ or ‘personal analytics’), which incentivises users to collect as much biodata as possible. Biodata encompasses a broad

spectrum of data related to the human body, including any information that reveals information on bodily states, functions, and interactions, such as heart rate, glucose levels, movement patterns, and hormonal changes (Lupton, 2016, 2020). Biodata often represents a condensed record of events or experiences, reduced to numerical variables or qualitative assessments. The scholarship surrounding the Quantified Self movement and wearable self-tracking technologies has critically examined the potential for such simplification, noting the risk of flattening complex, embodied experiences into mere data points (D’Ignazio and Klein, 2020; Lupton, 2016). These critiques demonstrate how datafication can abstract experiences from their embodied and contextual realities. *HCCC*’s choreographic approach can inspire the integration of embodied methods that have proven helpful in making algorithmic experiences less abstract, more relatable, and intimate.

The growing use of biodata raises significant concerns about agency, control, surveillance, and privacy (Gómez Ortega et al., 2023). The issues of data ownership and access are particularly critical for individuals tracking intimate data, especially in contexts where reproductive rights are threatened (Cao et al., 2024). Strategies such as counter-choreographies could inform ways platforms could support current efforts to improve transparency, support users in providing informed consent, and claim authority over their biodata (Grimme et al., 2025; Nellore and Zimmer, 2023). *HCCC* can support strategies that engage with biodata to subvert control mechanisms (Vincenzi et al., 2025) to challenge the surveillance of bodily autonomy.

Workplace and Labour Rights: This thesis focused on critiquing surveillance capitalism, with participants primarily reflecting on their personal use of Big Tech platforms. Although technology use on the job was mentioned in previous studies (see Section 6.4), this avenue was less explored. There is an opportunity for *HCCC*’s work to be adapted to concerns related to data extractive technologies in the workplace. Two avenues of exploration are particularly promising. First, to focus on the effects of these technologies on employees, especially those in jobs mediated by platforms, such as gig work and content creation. For example, the use of tracking algorithms by courier companies such as Deliveroo and Uber enables them to exercise control over their workforce and the daily lives of workers. This represents a form of choreographic power that, in turn, has a profound impact on creating precarious working conditions that are easily exploited by these logistical companies (Egert, 2022). In response to the challenges and broader issues posed by unfair and increasingly surveilled and datafied labour conditions, gig workers have been developing and adopting tactics to bypass and resist these practices (Bonini and Treré, 2024). In this vein, the *HCCC* approach can contribute to such efforts by inspiring alternative structures of cooperation and solidarity within labour unions and other forms of collective organisation.

Second, the *HCCC* approach can be expanded to incorporate issues related to labour within the technology industry. This expansion aims to support the critical reflection of employees who work for technology companies or are in-

volved in the production of technology-related products or services. In this case, ‘counter-choreographies’ can be articulated with bodily feelings of discomfort that technologists identify in their work. My choreographic approach can complement existing methodologies, such as the design of uncomfortable interactions (Benford et al., 2012) or the experience of discomfort in the use and development of technologies (Popova et al., 2024).

I see the potential for expanding the concept of ‘counter-choreographies’ to enable collective action against algorithmic discrimination and labour exploitation mediated through technological platforms.

Algorithmic Literacy: Finally, the choreographic approach could be integrated into existing practices to develop algorithmic literacy with people of all ages. I see the potential for counter-choreographies to be applied to pedagogical efforts. There is a legacy of the integration of dance and movement to improve student engagement in learning algorithmic processes (e.g. Papert, 1980). Recent examples include Body.Scratch (Arthur and Anh Tu, 2023), a tool designed for children and adolescents that uses the visual programming language Scratch with choreographed movements to engage learners in an embodied and cooperative process to grasp concepts in computer science. Data Theatre (Bhargava et al., 2022), an entry point for growing data literacy by engaging participants in the emotional and meaningful embodied performance of data stories. Bodygramming (Mikkonen, 2019), another approach that uses embodiment to develop an understanding of basic programming concepts in physical computing. All of these projects integrate embodiment- and movement-based practices as part of learning processes in computer science. I see a potential for our approach to be applied in these contexts to include forms of resisting and ‘countering’ those same processes in contrast to their assimilation.

The *HCCC* research can be combined with more advanced algorithms’ literacy assessments to analyse the effects of the choreographic approach proposed in this thesis. For example, employing the algorithmic literacy scale (Dogruel et al., 2022), a comprehensive measurement that captures two dimensions of algorithmic literacy: awareness and algorithmic knowledge.

Moreover, *HCCC* can be expanded to other domains that challenge the acceleration of technological growth associated with extractivist algorithmic processes. One example is Pollitt et al.’s, which uses dance improvisation in environmental education to help children experience weather as an integral part of their surroundings, rather than a distant concept, proposing a shift in how we engage with and learn about the natural world (Pollitt et al., 2021). Another example is the work by Bhowmik et al.’s who make use of choreography as a thermal and energetic inquiry into extractivism. In their project, *Heat Work*, they explore how combining choreography with machine learning could offer a novel methodology for negotiating the energy consumption and environmental impact of these systems (Bhowmik et al., 2025). Counter-Choreographies could challenge broader extractivist processes and advocate for deeper connections with land, culture, and community in rural contexts.

For example, they could complement the work within community-based initiatives that play a crucial role in the collection, analysis, and interpretation of environmental data (S Paris et al., 2017; Walker et al., 2018). Algorithms are embedded in complex socio-technical systems and therefore should be observed holistically, across the complexity that comprises human and nonhuman assemblages (Ananny and Crawford, 2018; Goatley, 2025).

HCCC provides promising approaches for HCI to harness awareness and critique of technology-based digital extractivism (Chagnon et al., 2022). Growing awareness of other aspects, as mentioned above, would allow people to expand on the critique of surveillance capitalism (Zuboff, 2015) and the prevalence of data extractivism in our societies.

I conclude this chapter by encouraging artists, technologists, and researchers to continue developing work that advances algorithmic resistance in everyday life. This includes not only revealing algorithms and their practices, but also envisioning alternative approaches that foster a ‘critical audience’ essential to drive meaningful change in transparency and accountability (Kemper and Kolkman, 2019). Ultimately, this calls for a continued pursuit of counter-choreographies that challenge inequitable design and use of algorithms in society.

Chapter 10

Conclusions

*“...that the performance of certain kinds of gestures, athleticisms, inversions and frequencies may initiate so many political and choreographic **counter-movements**, to reveal more desirable modes of living and moving in this crime scene we all stand on, move on, and call, so innocently ‘the global.’”*
- André Lepecki in Drawing with Feet, Walking on Hands (2009)

10.1 Summary of Contributions

This chapter provides an overview of the research findings presented in this dissertation. In summary, *HCCC* explores the following question: how can a choreographic approach to HCI and computational arts increase awareness of online tracking, and inspire behavioural change towards data-extractive technologies? Through an examination of diverse outcomes (as described in Chapter 9), this research identifies key findings across conceptual, critical, artistic, designerly and technical domains:

- Design and documentation of a browser extension that exposes tracking through sonification and visualisation techniques (see Chapter 4); this work created a sensory entry point into the experience of online tracking, providing valuable insights into its impact through Chapters 5 and 6, which share personal accounts of audience members and participants about their experiences with the browser extension.
- Design and documentation of the *HCCC* performance piece and an empirical report on the effectiveness of the work (see Chapter 5); the findings reveal how the performance effectively increased the audience’s understanding of the prevalence of online tracking algorithms. In addition, the embodied and choreographic aspects of the performance allowed them to critically engage with data tracking and its implications for power dynamics and personal agency.
- Design and documentation of the *HCCC* workshop and an empirical report on the effectiveness of the work (see Chapter 6); the findings demonstrate how the workshop supported participants in developing an

understanding of their limited agency concerning online tracking, encouraging them to generate ideas to reclaim agency over their data.

- Design and documentation of the *HCCC* 12 scores, hosted on a website, that expose different aspects of online tracking. An analysis of a study with five participants who engaged with the 12 scores over two weeks, alongside form responses and interviews on the use of the *HCCC* website (see Chapter 7); this study found that engaging with the scores led to increased awareness and reflection on one’s agency in relation to online tracking, prompted significant behavioural changes, and underscored the importance of bodily involvement.
- A final exhibition and public launch of the *HCCC* the score’s collection website, along with a video and printed formats (see Chapter 8);
- ‘Counter-choreographies’, a new approach to awareness of data tracking and user empowerment exemplified in all the above-mentioned and discussed in Chapter 9;

The findings of this research primarily address the role of embodiment and choreography in the context of artistic research and critical technical practice. A detailed reflection on the findings can be read in Chapter 9, along with suggestions for future research and study, applicable to both my own work and the investigations of other researchers within computational arts and HCI.

10.2 Conclusion

Human-Computer Counter-Choreographies is a practice-based research project that critically examines the impact of pervasive online tracking algorithms.

Using a methodology that integrates artistic research, critical design, choreography, and embodied sense-making, *HCCC* employs choreographic practices to raise awareness of the often hidden influence of data tracking on individuals and society. The research first focused on designing activities that surfaced the prevalence of online tracking and enabled participants to critically reflect on it. Then it explored ways to encourage user behavioural change specific to their daily usage of apps and digital services.

The project consisted of a custom browser extension, a live-coding performance, a workshop series, and a web-based artwork, involving more than 90 participants in an iterative research process. Mixed qualitative and quantitative data collected from participants demonstrated that the embodied and choreographic approach significantly increased their awareness of the prevalence of data tracking. It enabled more intimate, visceral approaches to engaging on complex issues surrounding data tracking. Ultimately, *HCCC* helped participants reflect on their entanglement with tracking algorithms in their day-to-day lives and find ways to disentangle.

HCCC contributes to the fields of computational arts and human-computer interaction in two key ways: first, by introducing a novel approach that bridges

choreography and the study of online tracking; and second, by providing empirical evidence for the effectiveness of choreography as a tool to promote critical algorithmic awareness in everyday life.

Human-Computer Counter-Choreographies advances approaches that counter extractivist technologies by centring bodies in growing awareness and critical reflection of online tracking. It encourages new ways of drawing attention to online tracking through an embodied choreographic approach. The concept of counter-choreographies prompts people to critically reflect on online tracking and supports behavioural change in relation to such algorithms. In doing so, it empowers users to engage with data-extractive technologies more critically, paving the way for more equitable data futures.

Appendix A

Links and Supplemental Materials:

A.1 Browser Extension Links

- Link to video demo of the browser extension (2023);
- Link to code repository.

A.2 Performance Links and Supplemental Materials

- Link to online archive: video digest and performance trailer (2024);
- Link to post-performance questionnaire (2023-2024).

A.3 Workshop Links and Supplemental Materials

- Link to workshop presentation (2023);
- Link to post-workshop questionnaire (2023).

A.4 Scores Website and Supplemental Materials

- Link to study website (2024);
- Link to post-study questionnaire (2024).

A.5 Exhibition Links and Supplemental Materials

- Link to The Everyday Algorithms exhibition, curated by Shelly Knotts at the NewBridge Gallery, Newcastle UK (2025);
- Link to the HCCC Scores' public website launched during the exhibition (2025);
- Link to video: Joana Chicau performing the HCCC scores (2025).

Appendix B

Photographic Documentation

B.1 Scores Collection

HUMAN-COMPUTER COUNTER-CHOREOGRAPHIES

1. WARM-UP

- ↪ Grab a pen and paper or a digital equivalent annotating tool.
- ↪ List the apps and online services you use daily (e.g.: weather or banking apps, maps, social media, or other websites you frequently access using your phone or computer)
- ↪ Around each app list the data you think the app collects (e.g.: date of birth, gender, location, phone number, audio data, photos, clothing size, sexual orientation, religious or philosophical beliefs, trade union membership, salary info...)
- ↪ Create a movement for each type of data. Perform it as a dance!

Figure B.1: Score no 1 in *HCCC* scores website (2025).

HUMAN-COMPUTER COUNTER-CHOREOGRAPHIES

2. GETTING PERSONAL

- ↪ Think of the top 5 data you consider most personal or intimate;
(e.g.: date of birth, gender, location, audio data, photos, clothing size, sexual orientation, salary info...)
- ↪ Note down when you think that data is tracked, including if you're explicitly asked for that data on apps/ online services.
- ↪ At the end of the day, record yourself performing that movement the same number of times as you noted down.

Figure B.2: Score no 2 in *HCCC* scores website (2025).

HUMAN-COMPUTER COUNTER-CHOREOGRAPHIES

3. DAILY GESTURES

- ↪ Choose one of the apps or online services you use day-to-day.
- ↪ List all the gestures you perform in the app, such as:
scroll / select / type / trash / play...
- ↪ For 24 hours, substitute one of the gestures for another movement of your choice.

Figure B.3: Score no 3 in *HCCC* scores website (2025).

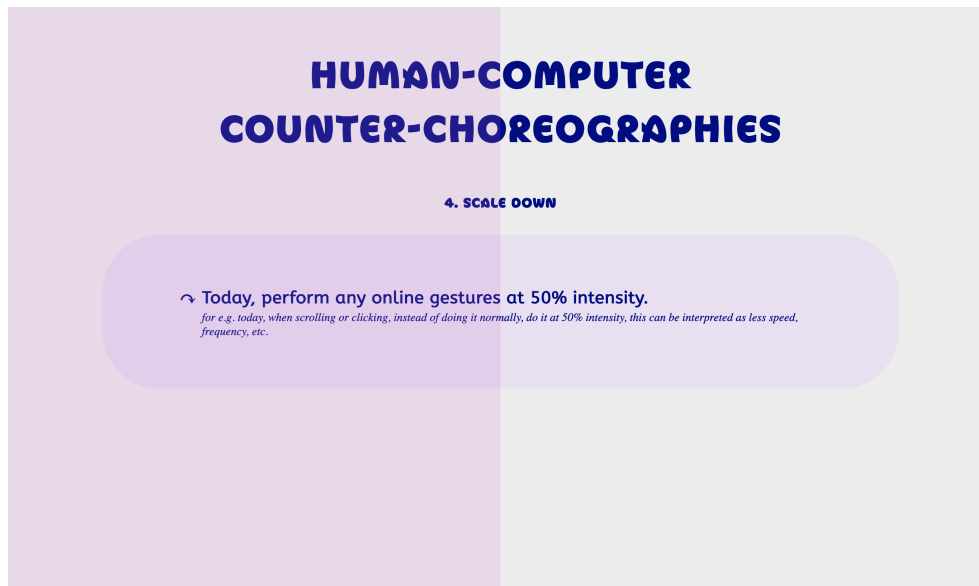


Figure B.4: Score no 4 in *HCCC* scores website (2025).

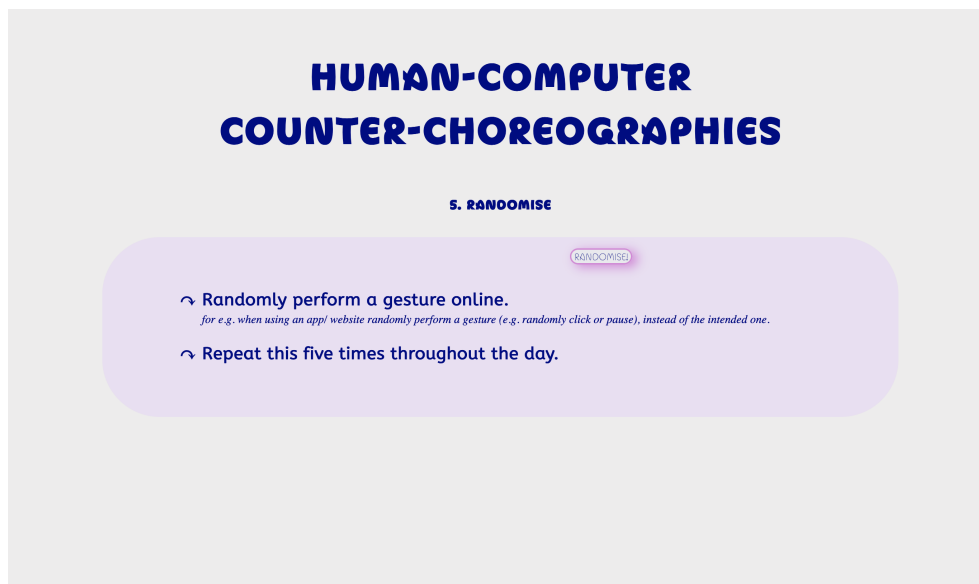


Figure B.5: Score no 5 in *HCCC* scores website (2025).

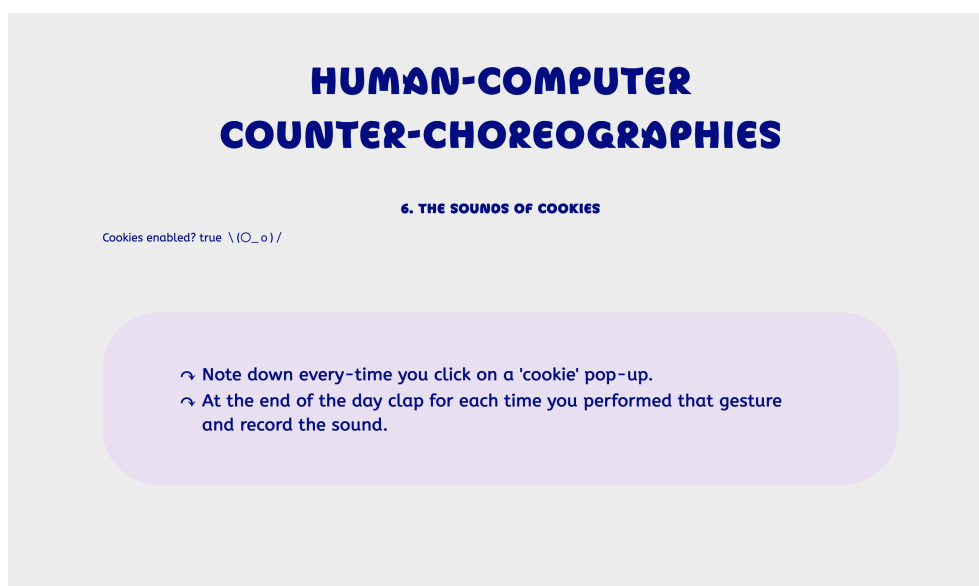


Figure B.6: Score no 6 in *HCCC* scores website (2025).

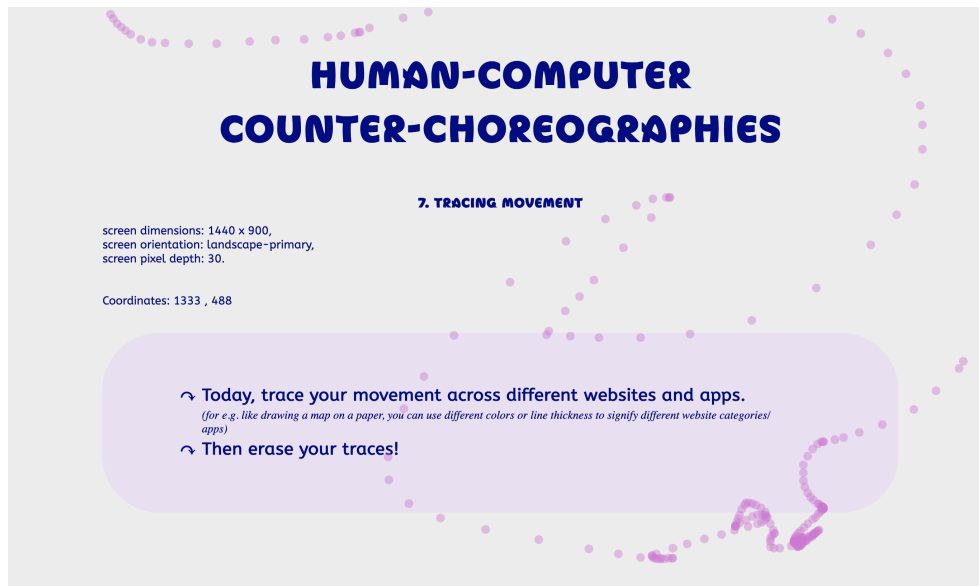


Figure B.7: Score no 7 in *HCCC* scores website (2025).

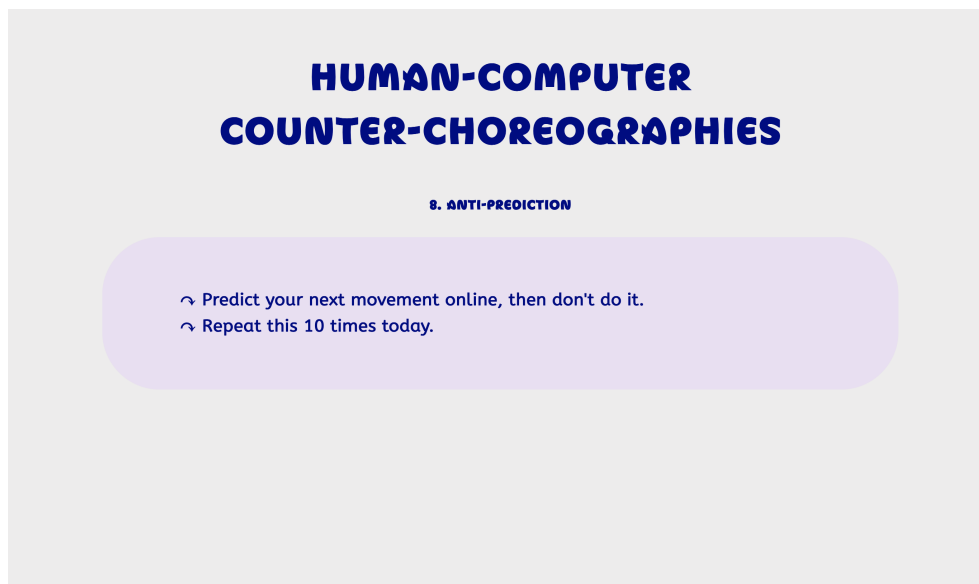


Figure B.8: Score no 8 in *HCCC* scores website (2025).

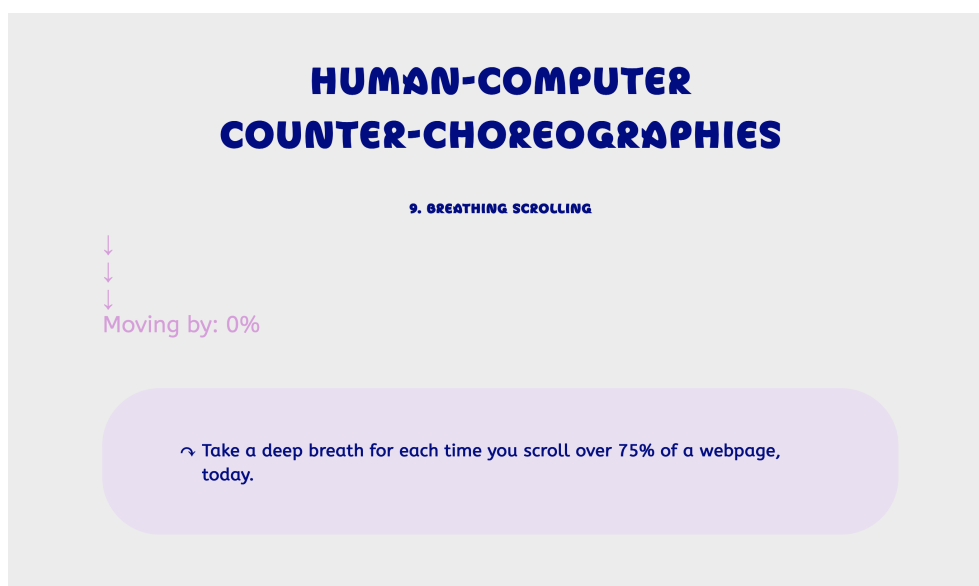


Figure B.9: Score no 9 in *HCCC* scores website (2025).

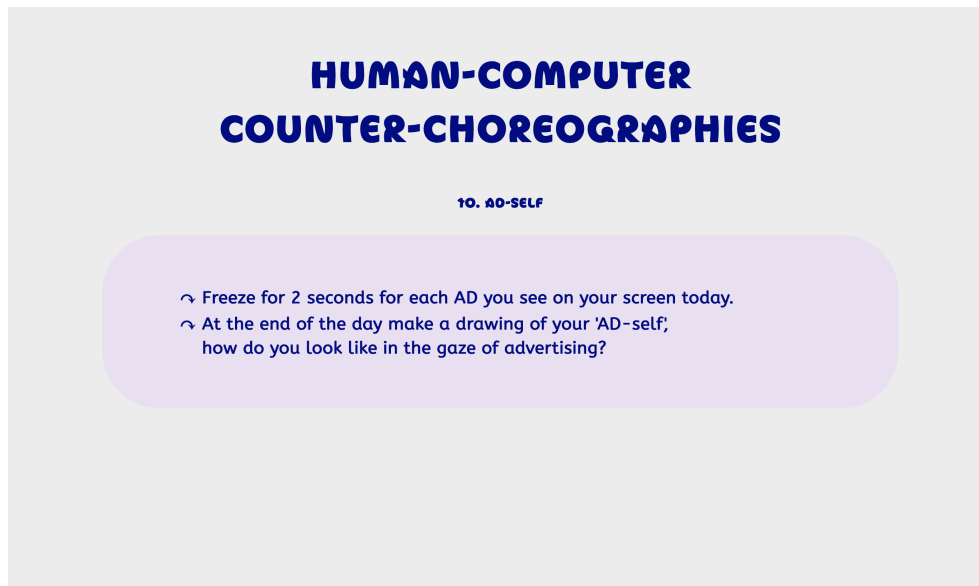


Figure B.10: Score no 10 in *HCCC* scores website (2025).

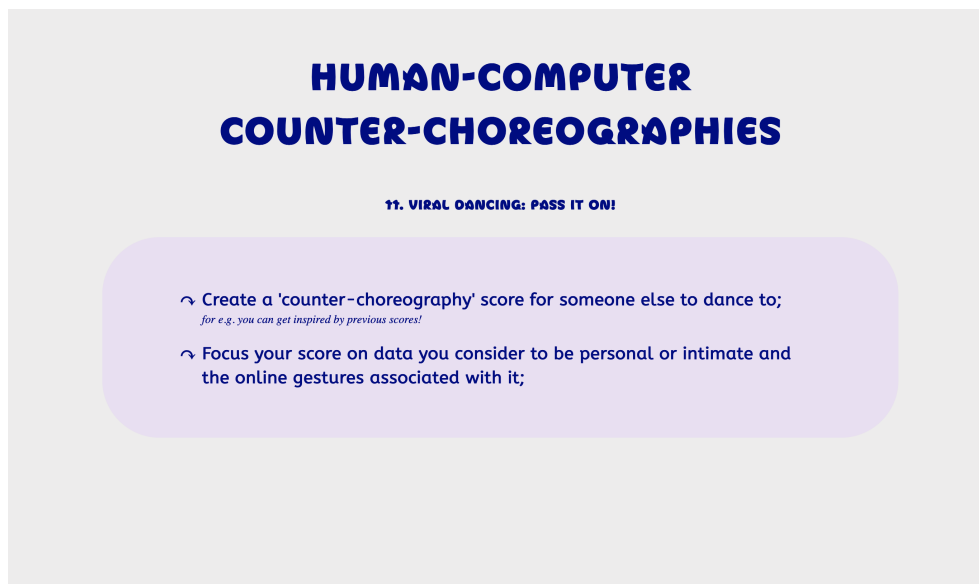


Figure B.11: Score no 11 in *HCCC* scores website (2025).

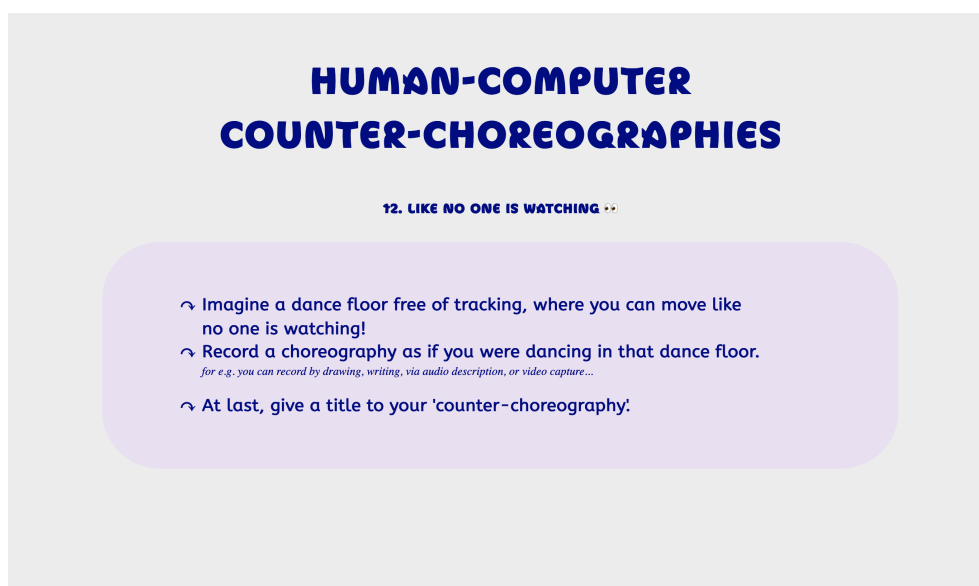


Figure B.12: Score no 12 in *HCCC* scores website (2025).



Figure B.13: All $HCCC$ scores from the website used in the study (2025).

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