Human-Computer Interaction

COMS30029

aka **#HCI_Theory**

Dan Bennett

Week 7: What Next?

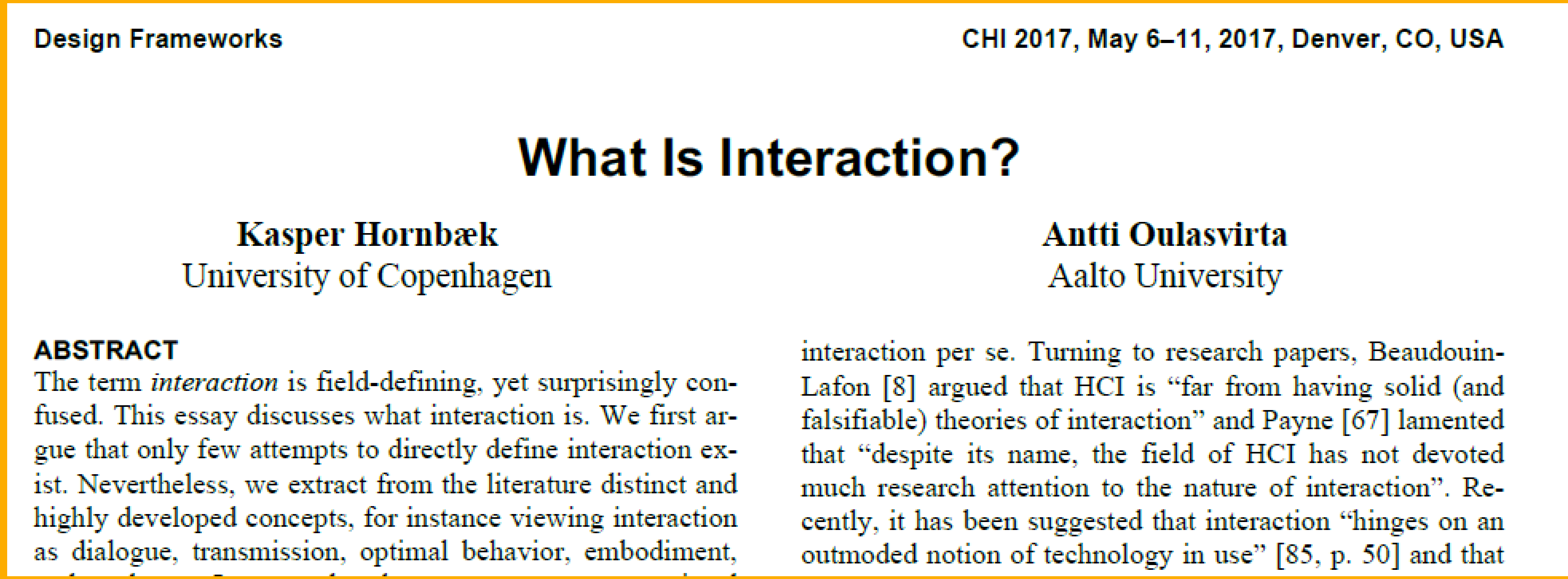
Chunk 1: Computation and Complexity

Week 7: What's Next?

Chunk 1: Computation and Integration

Managing and Thinking about Complexity

REQUIRED READING:



What Is Interaction?

Kasper Hornbæk
University of Copenhagen

Antti Oulasvirta
Aalto University

ABSTRACT
The term *interaction* is field-defining, yet surprisingly confused. This essay discusses what interaction is. We first argue that only few attempts to directly define interaction exist. Nevertheless, we extract from the literature distinct and highly developed concepts, for instance viewing interaction as dialogue, transmission, optimal behavior, embodiment,

interaction per se. Turning to research papers, Beaudouin-Lafon [8] argued that HCI is "far from having solid (and falsifiable) theories of interaction" and Payne [67] lamented that "despite its name, the field of HCI has not devoted much research attention to the nature of interaction". Recently, it has been suggested that interaction "hinges on an outmoded notion of technology in use" [85, p. 50] and that

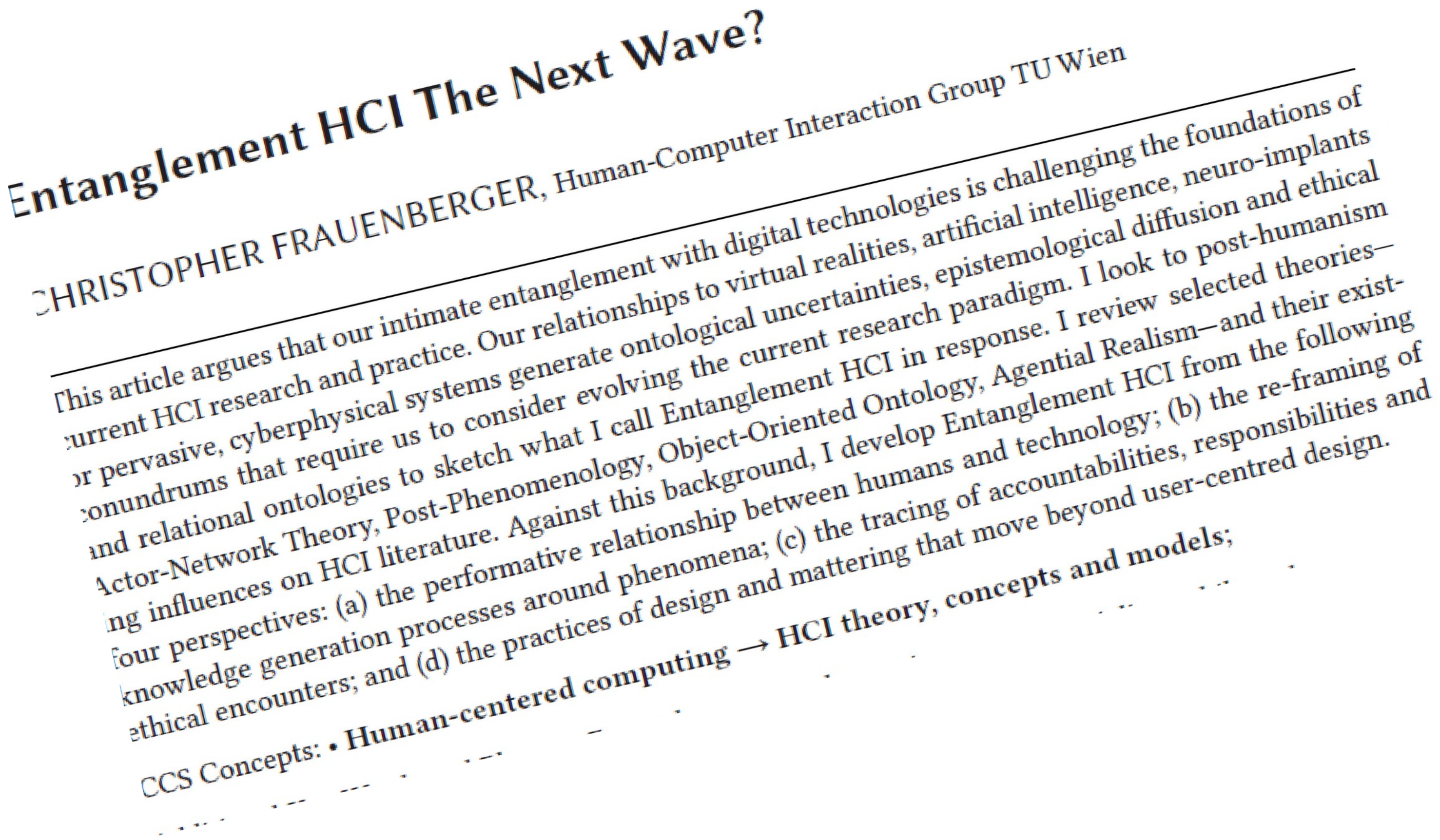
What is Interaction by Hornbæk and Oulasvirta

Wave Review

- **1st wave** – How do peoples' brains drive interaction, and how do we apply natural science to interaction?
- **2nd Wave** – how do bodies and situations get involved, and how can we create native HCI theory?
- **3rd Wave** –OK, but what about society, what about difference, what about happiness and ethics?

Each built on (or reacted to) prior waves, and responded to developments in society and technology

Complexity (?)

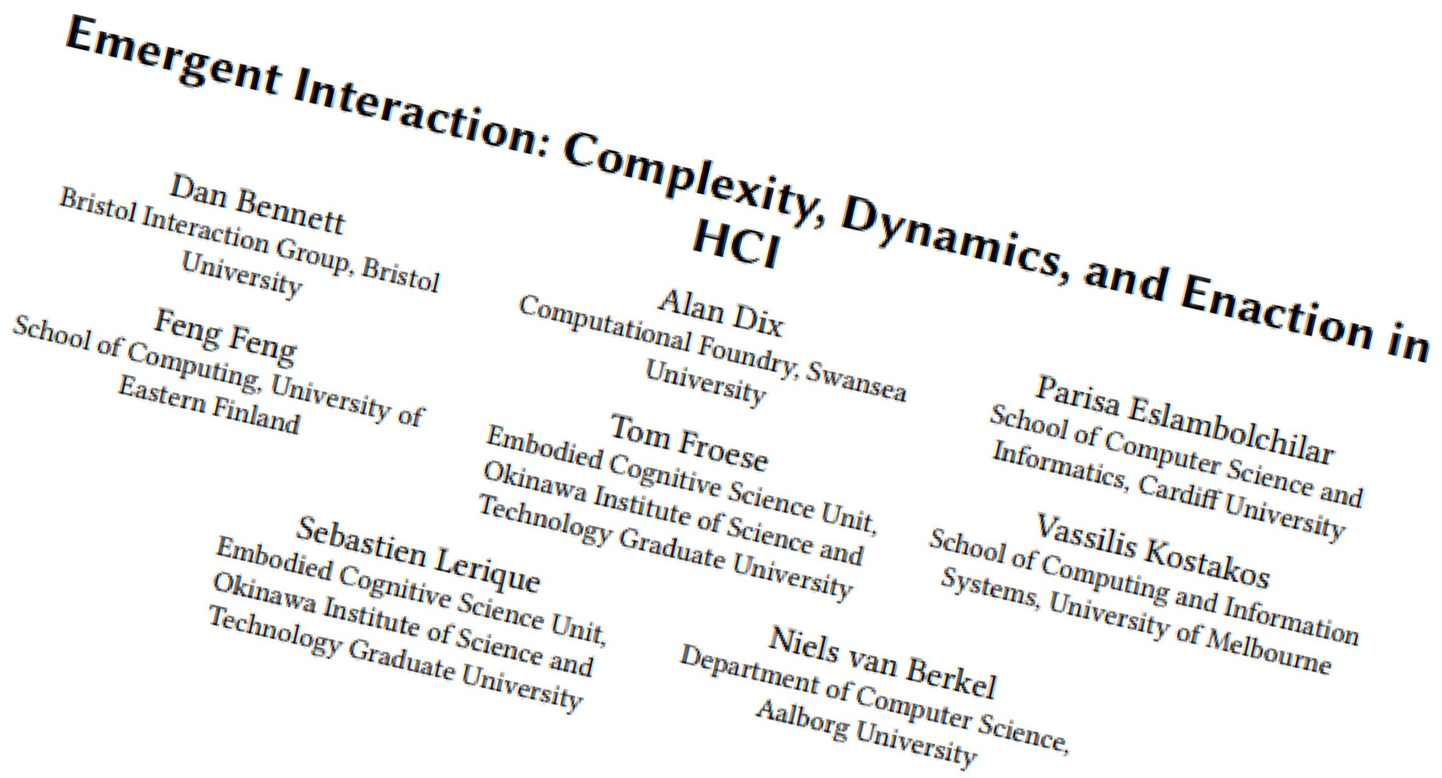


Entanglement HCI The Next Wave?

CHRISTOPHER FRAUENBERGER, Human-Computer Interaction Group TU Wien

This article argues that our intimate entanglement with digital technologies is challenging the foundations of current HCI research and practice. Our relationships to virtual realities, artificial intelligence, neuro-implants or pervasive, cyberphysical systems generate ontological uncertainties, epistemological diffusion and ethical conundrums that require us to consider evolving the current research paradigm. I look to post-humanism and relational ontologies to sketch what I call Entanglement HCI in response. I review selected theories—Actor-Network Theory, Post-Phenomenology, Object-Oriented Ontology, Agential Realism—and their existing influences on HCI literature. Against this background, I develop Entanglement HCI from the following four perspectives: (a) the performative relationship between humans and technology; (b) the re-framing of knowledge generation processes around phenomena; (c) the tracing of accountabilities, responsibilities and ethical encounters; and (d) the practices of design and mattering that move beyond user-centred design.

CCS Concepts: • **Human-centered computing → HCI theory, concepts and models;**



Emergent Interaction: Complexity, Dynamics, and Enaction in HCI

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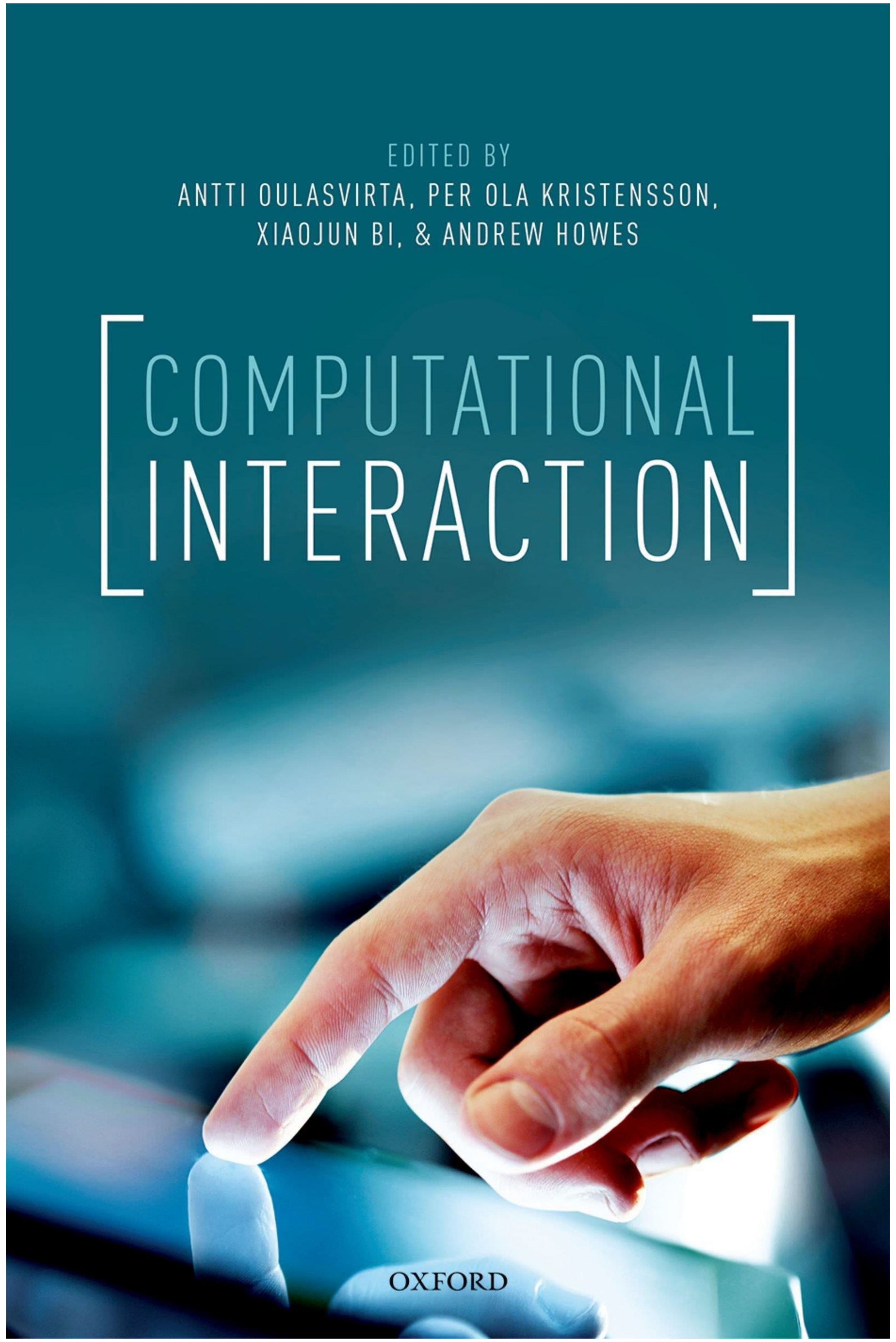
Department of Computer Science, Aalborg University

What changes might have made issues **different in kind** from 20 years ago**?**

Most previous work assumed users came to the tech with goals and motivations.
Are user-tech relations more complex: can tech influence our values, motivation, the kinds of goals we form?

What to do?



Computational Interaction

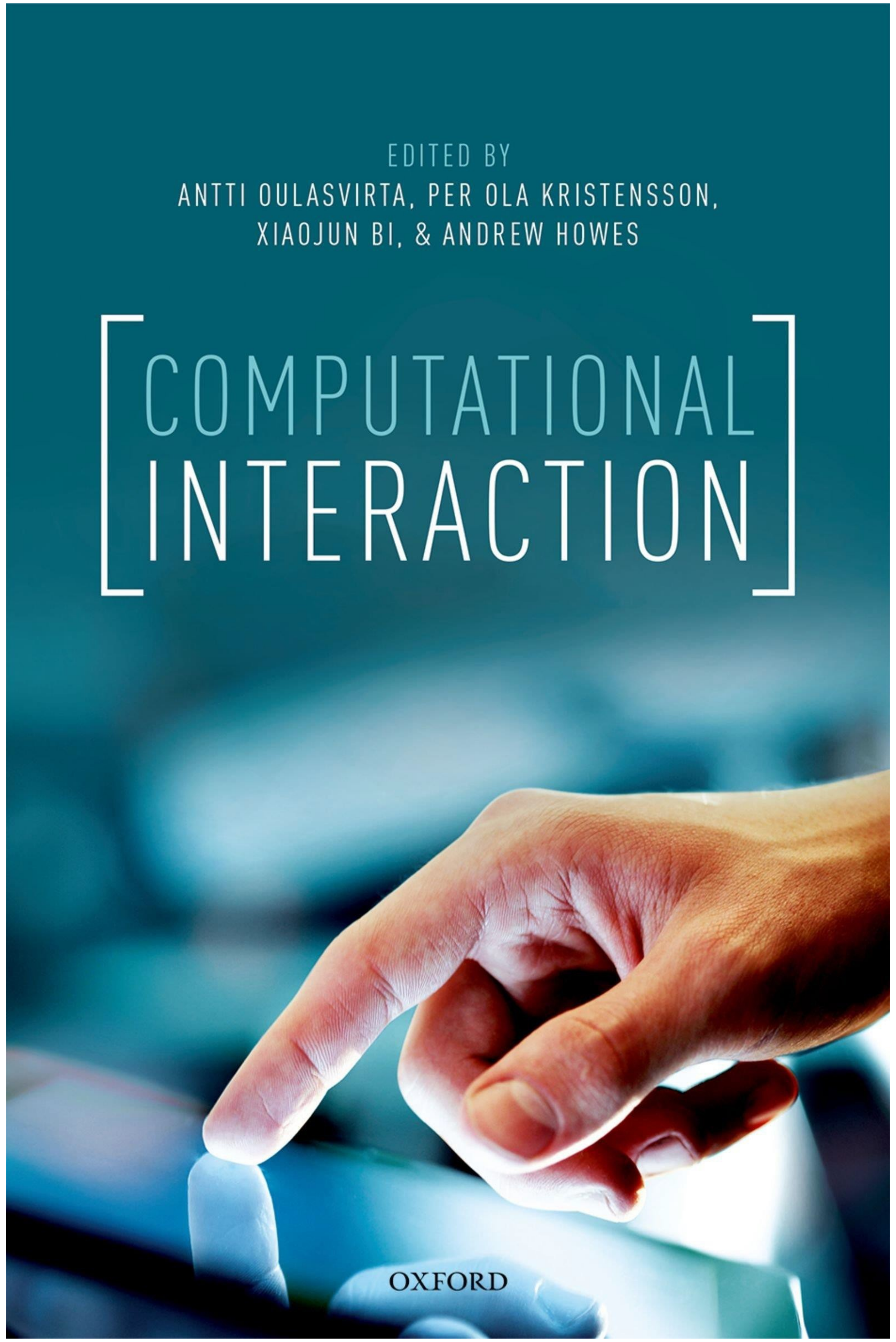
- Current issues need to be addressed using computational methods

- Algorithms and mathematical models to enhance and explain interaction

- **Evaluative models:** estimating the quality of an interface design

- **Predictive models:** of the user's behaviour or preferences, used to design / adapt interfaces

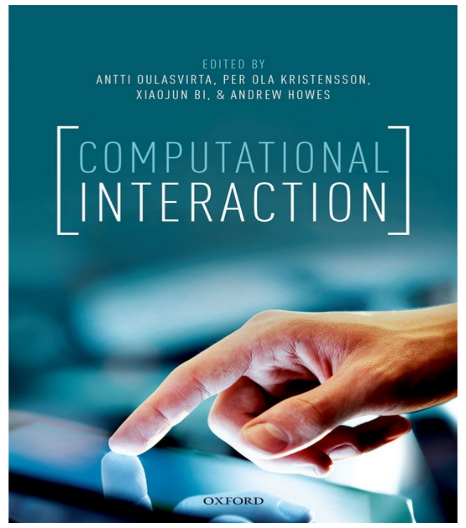
Does this sound familiar?

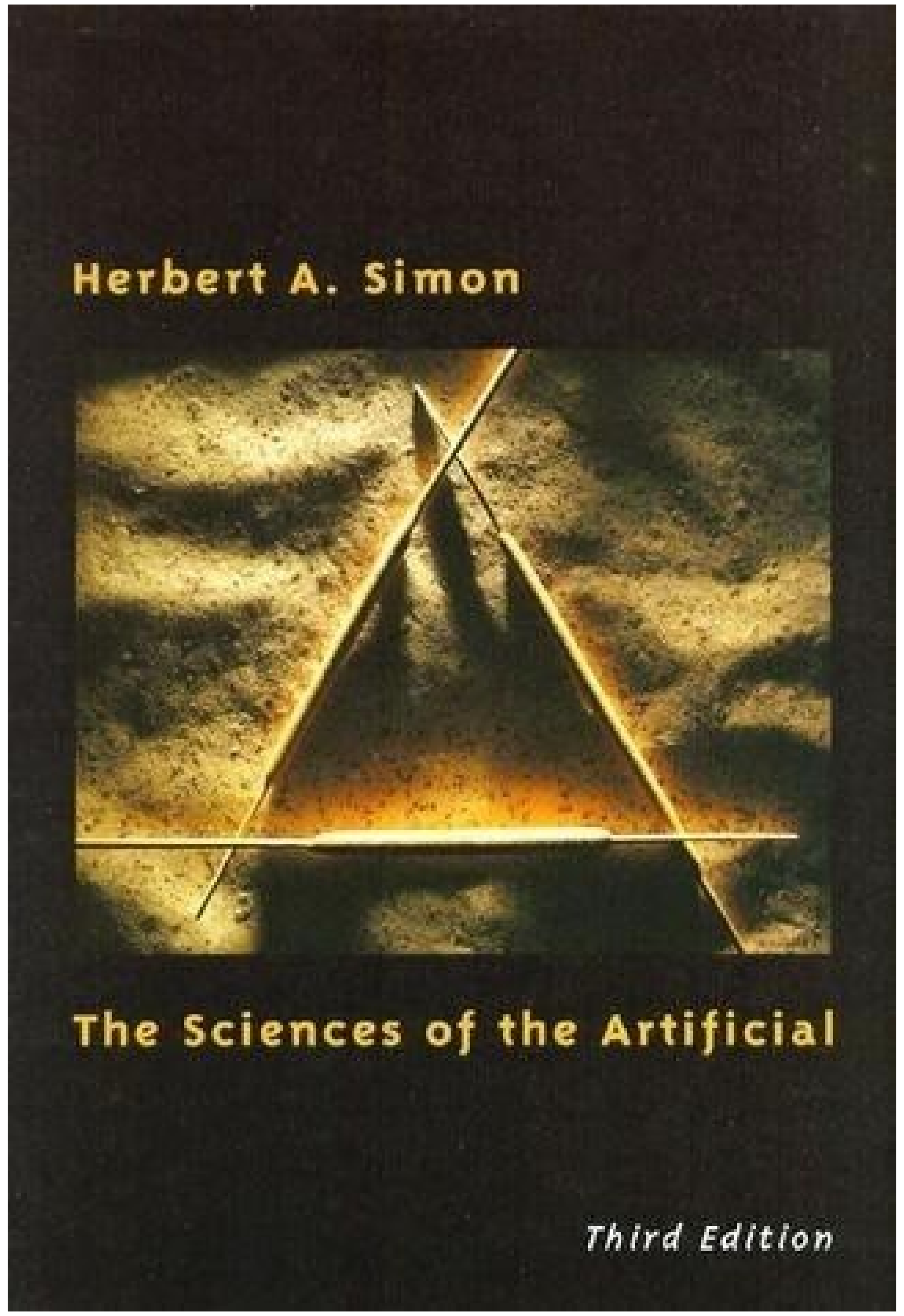


First Wave Throwback?

- Similar foundations: computational (brain-centric) models of human behaviour
- Now turbocharged with modern computational methods
- At current scales, data-driven interfaces and methods are essential (they say).
- Essential to letting technologies Adaptat to context (machine vision, neural computing)
- Not just “one user one device”: pushing beyond lab psychology

HCI as a “Science of the Artificial”





- *“The creation of artefacts for predefined goals and functions”.*

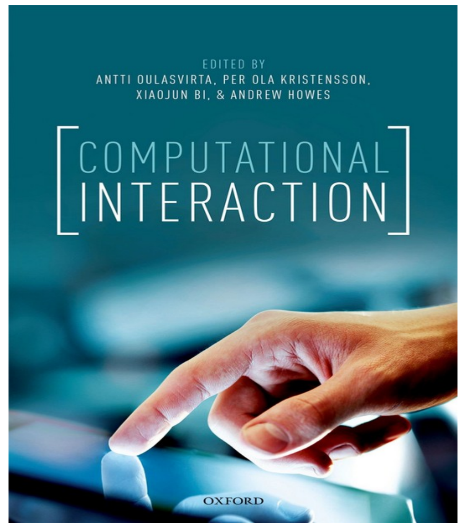
- Aligns HCI with disciplines like Medicine & Engineering

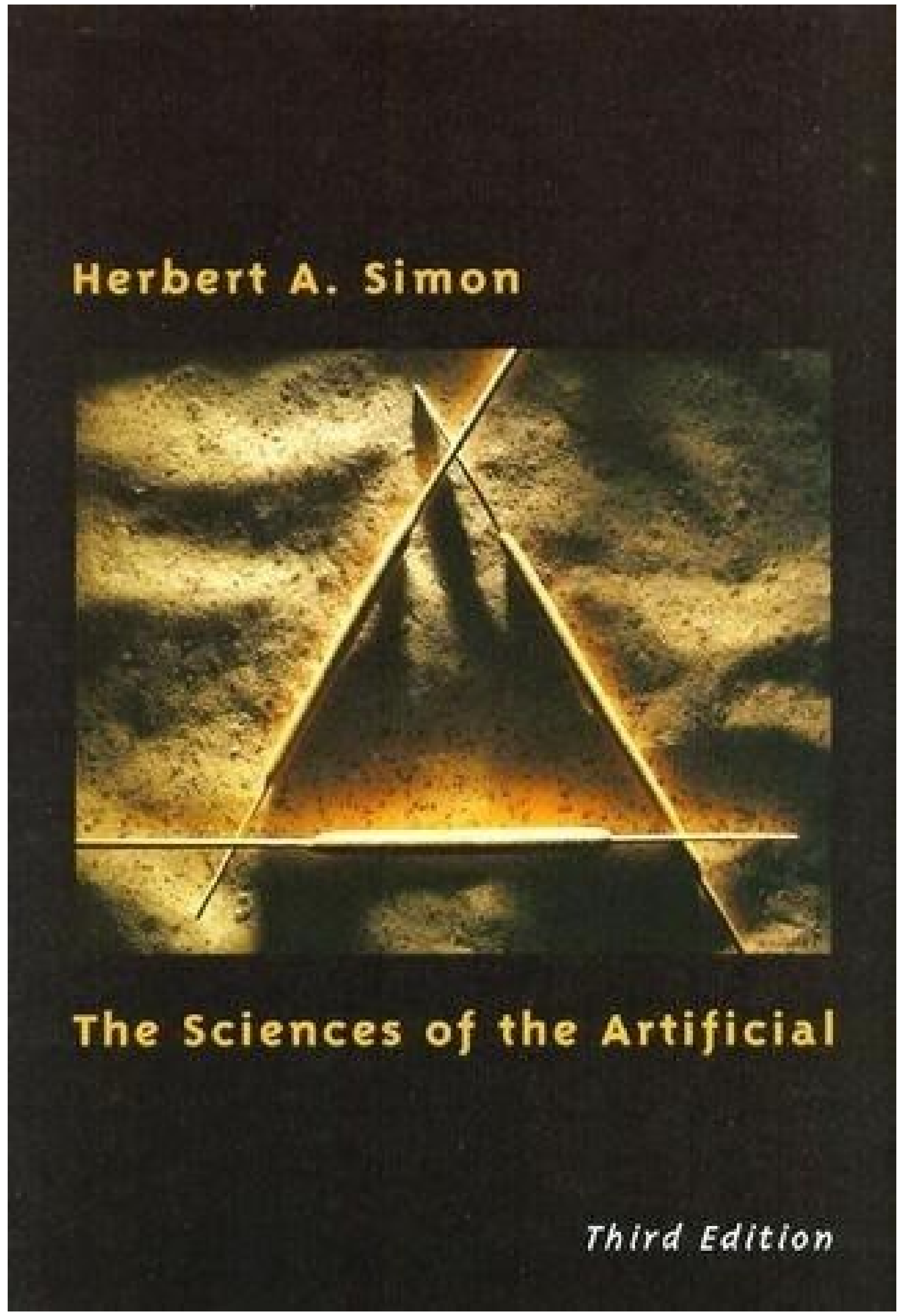
- **Not a natural science**
  (NS doesn’t aim to intervene / change nature).

- **Not an art**
  (because arts don’t focus on goals)

Do we agree?

HCI as a “Science of the Artificial”





Three key aspects to a **science of the artificial**

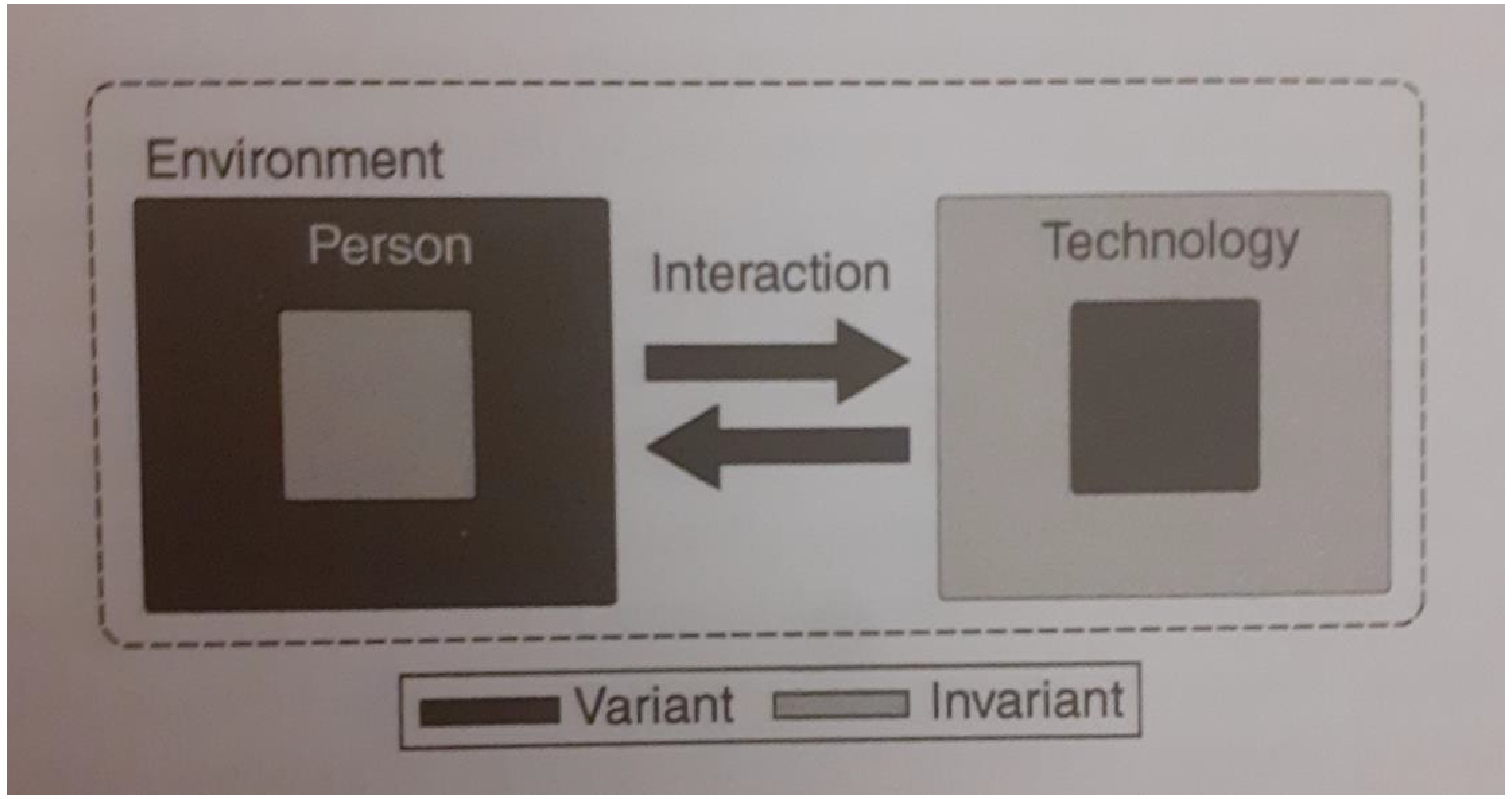
1. Distinction between **Inner vs Outer environments**
2. **Simulation and Modelling** as modes of construction
3. **Empirical research**

HCI as a “Science of the Artificial”

1. “Inner and Outer Environment”

Inner: the nature of the device / object
Outer: the nature of the context

The same division applies to people and devices.



The inner “algorithm” of human behaviour – what do we think about this?

HCI as a "Science of the Artificial"

1. "Inner and Outer Environment"

Inner: the nature of the device / object
Outer: the nature of the context

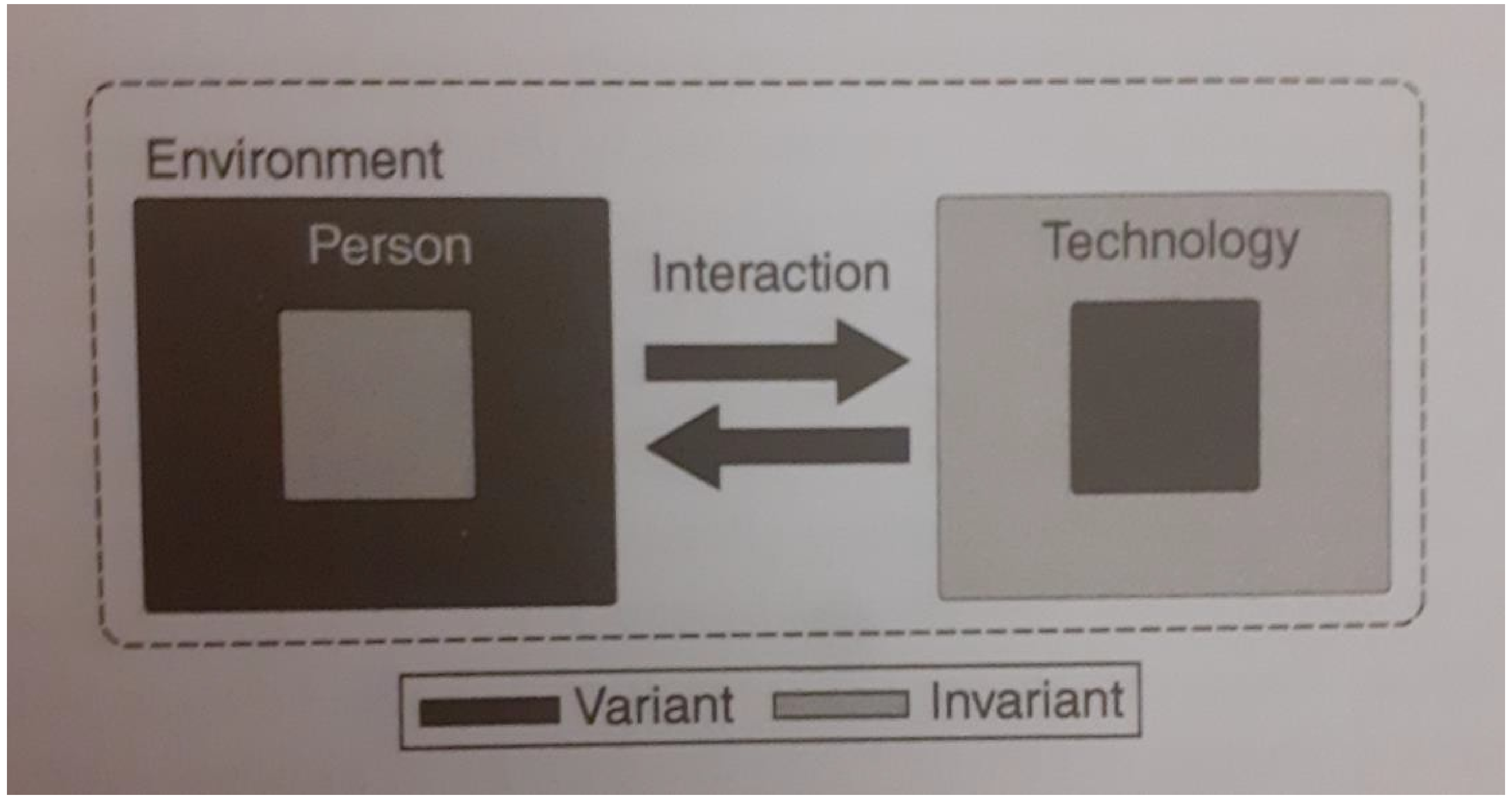
Variant and Invariant properties

Variant: changeable

- ***Tech***: algorithm, interface surfaces
- ***People***: behaviours and skills

Invariant: (effectively) fixed

- **Tech:** Operating System, hardware
- **People:** biological limits on perception and behaviour, **(culture, social norms??)**



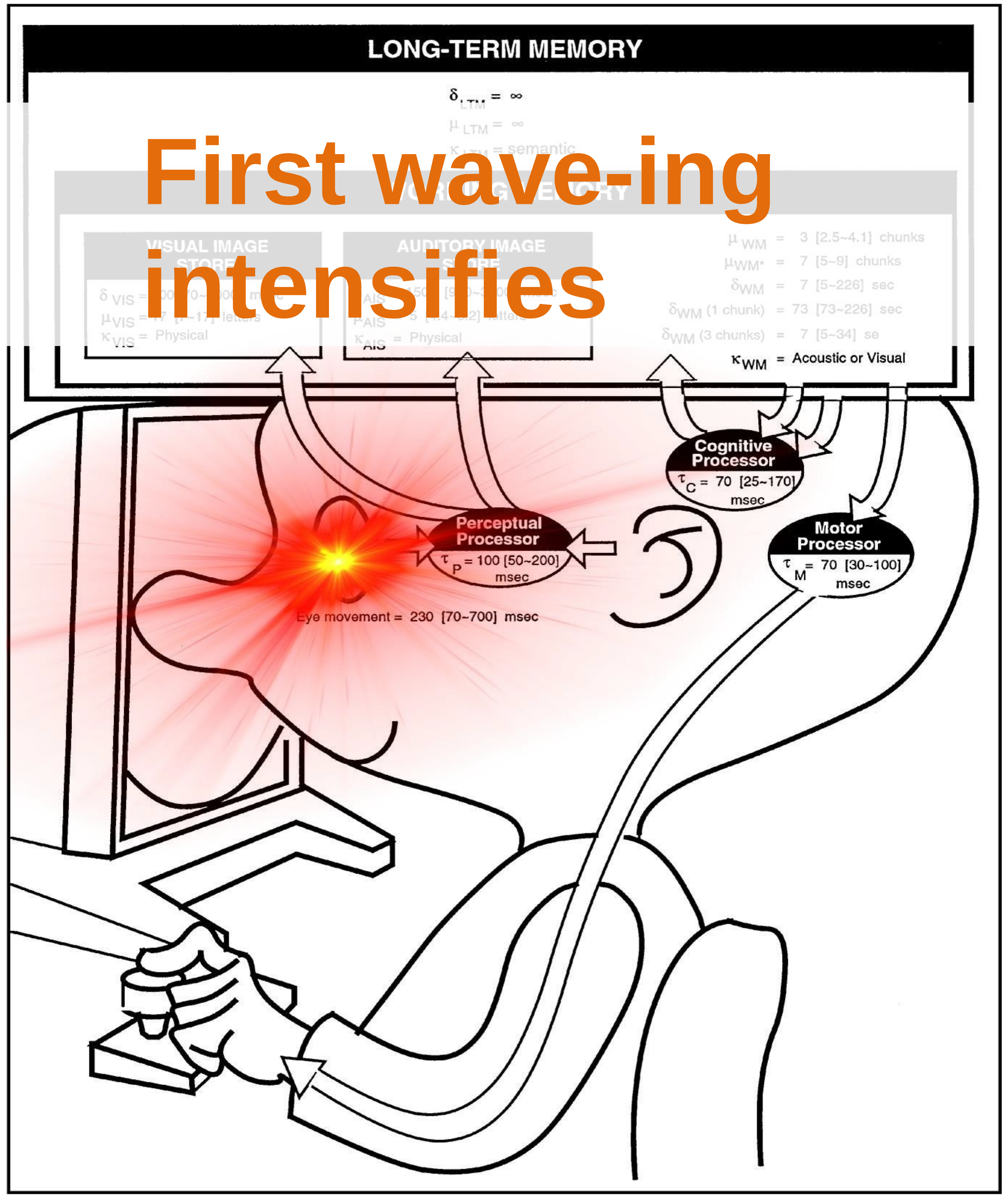
(in)variance is scale dependent:

What matters: Is it useful to *model* X as invariant at the time-scale of the interaction?

HCI as a “Science of the Artificial”

2. Simulation and Modelling

- Simulations of interaction components support “counterfactual” reasoning (“what might be”)
- Explore the implications of a theory by testing it in complex scenarios
- Theories can be built directly into systems as models [acting based on the probable “state” of the user]



HCI as a “Science of the Artificial”

3. Empirical Research

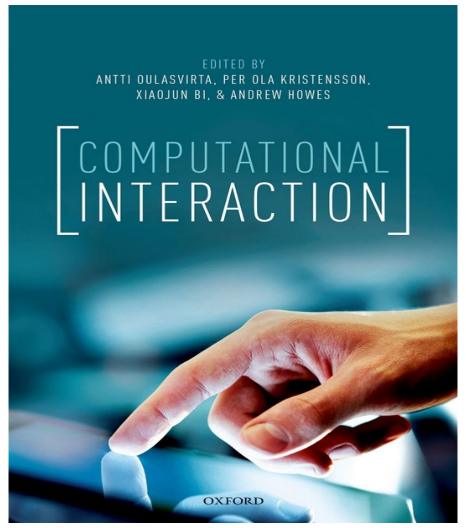
- Beyond lab studies: a more integrated “in the wild” approach

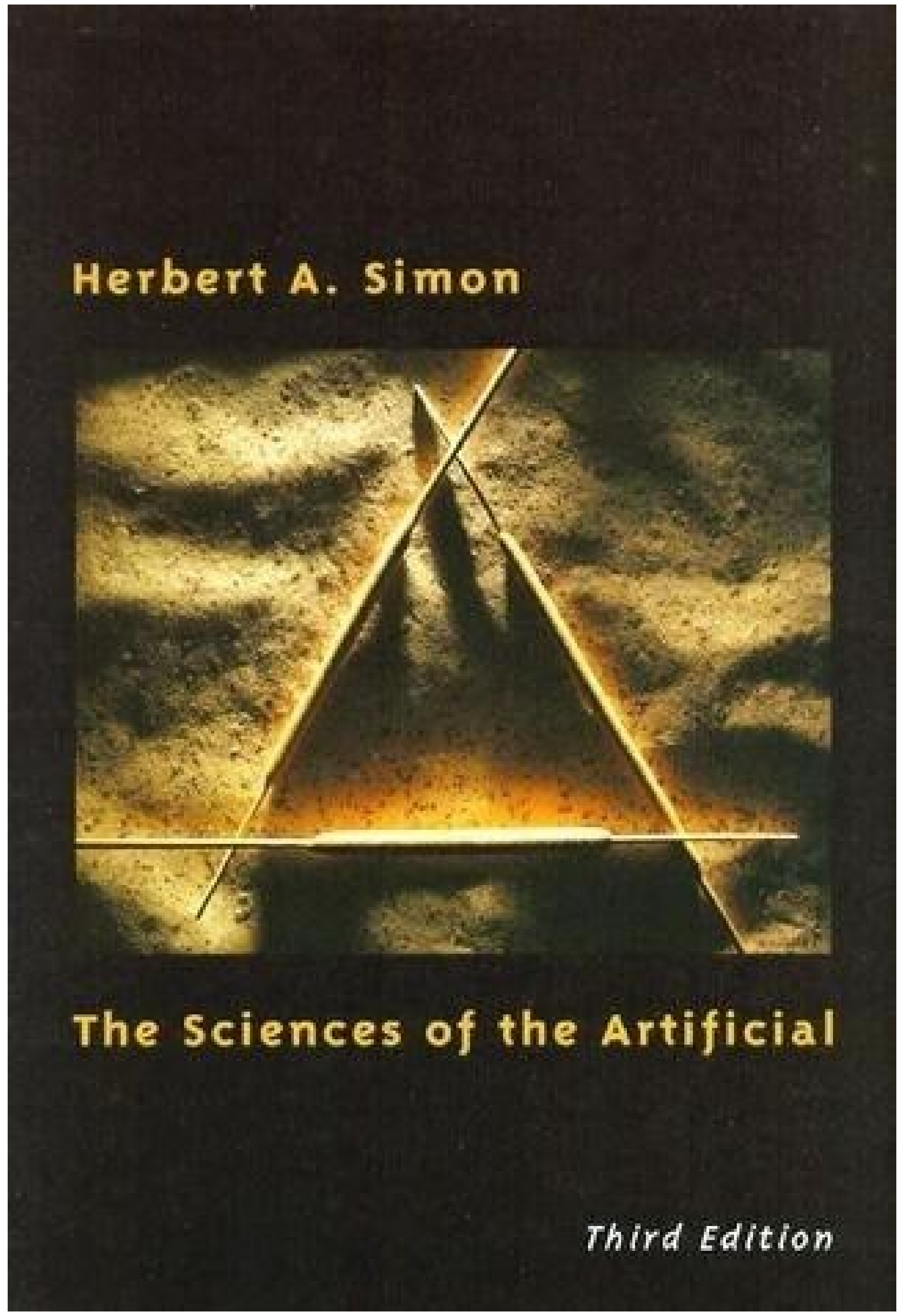
- Testing of the technology in “outer environments” (the real world)

- Theories associate variables with interaction events, allowing them to be tested and adapted based on results

- By integrating the model into the technology, we are also testing the model (and thereby the theory)

HCI as a “Science of the Artificial”





A highly systematised approach to design

Theories are formalised in (often complex) equations, and (often massively parameterised) models

Interaction variables can be anything

- **the size and position of a button**
- **the mix of content types**
- **amount of time spent scrolling**
- **inferred affect of the user**
- **sense of competence?**

Computational Interaction in Practice

1. “Inner and Outer Environment”
2. Simulation and Modelling
3. Empirical Research

Optional reading:

It’s Time to Rediscover HCI Models

Antti Oulasvirta, Aalto University

Insights

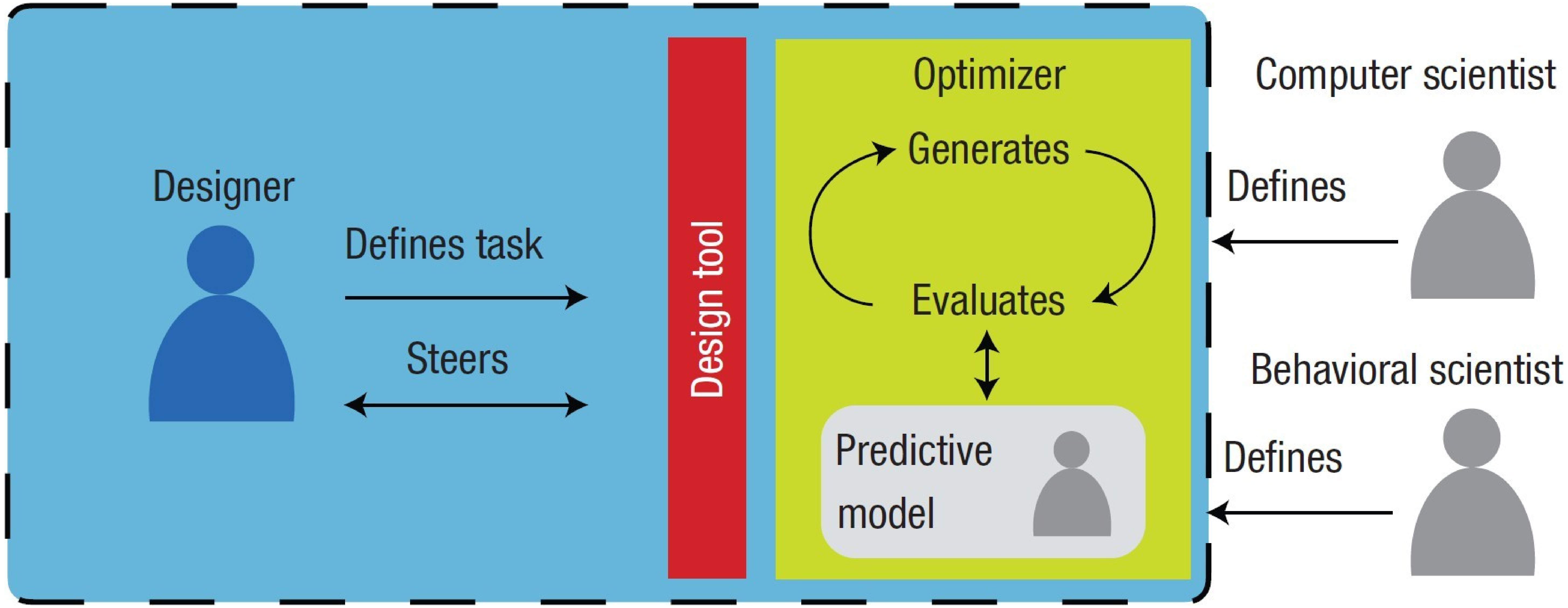
- Modeling has improved significantly since GOMS and Fitts’s law.
- We have a new bedrock in powerful computational models that can explain and predict behavior with higher fidelity and address a broader scope beyond point-and-click interfaces.
- The most far-reaching development is that we have learned how to use models to drive the algorithmic generation and adaptation of UIs.

Components:

- **Predictive model to support interface design**

- a turbocharged, adaptive, version of GOMs.

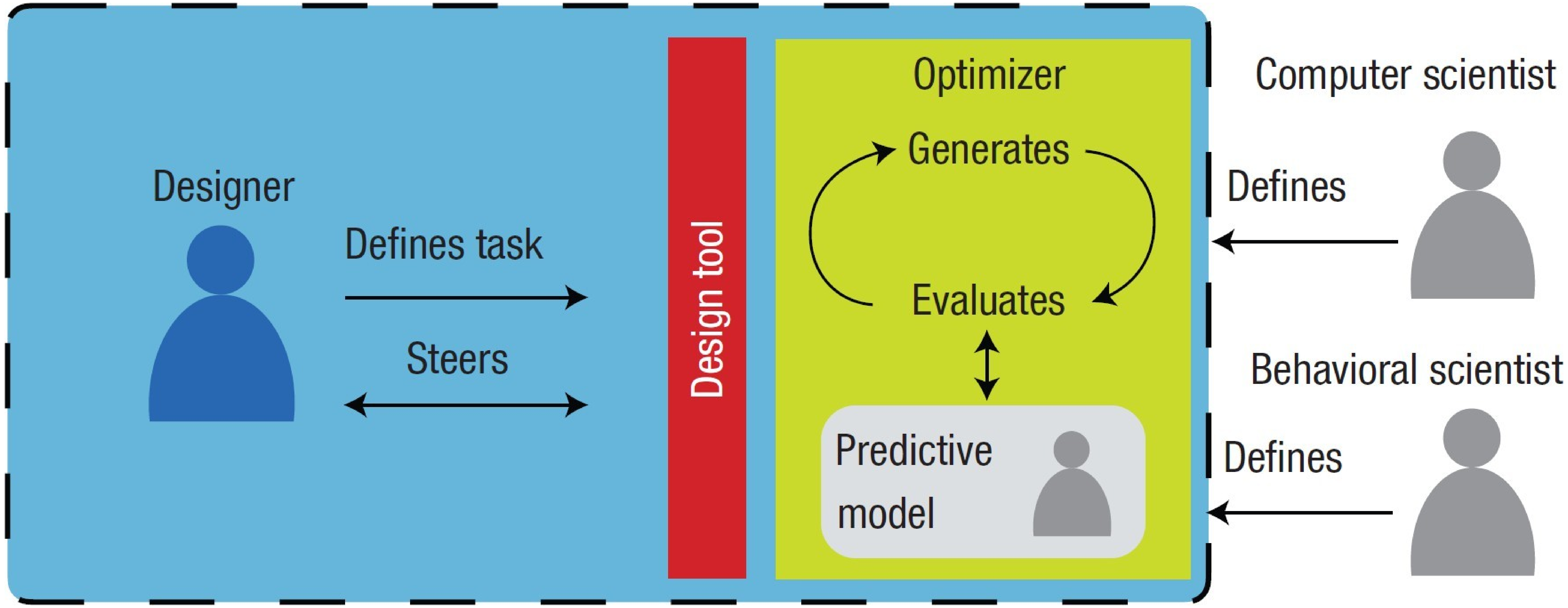
- Models specific to use case



Components:

- **Predictive model**
- **Optimizer**

e.g. a generative function (e.g. combinatorial, or GAN), and a fitness function, evaluating outputs against the model

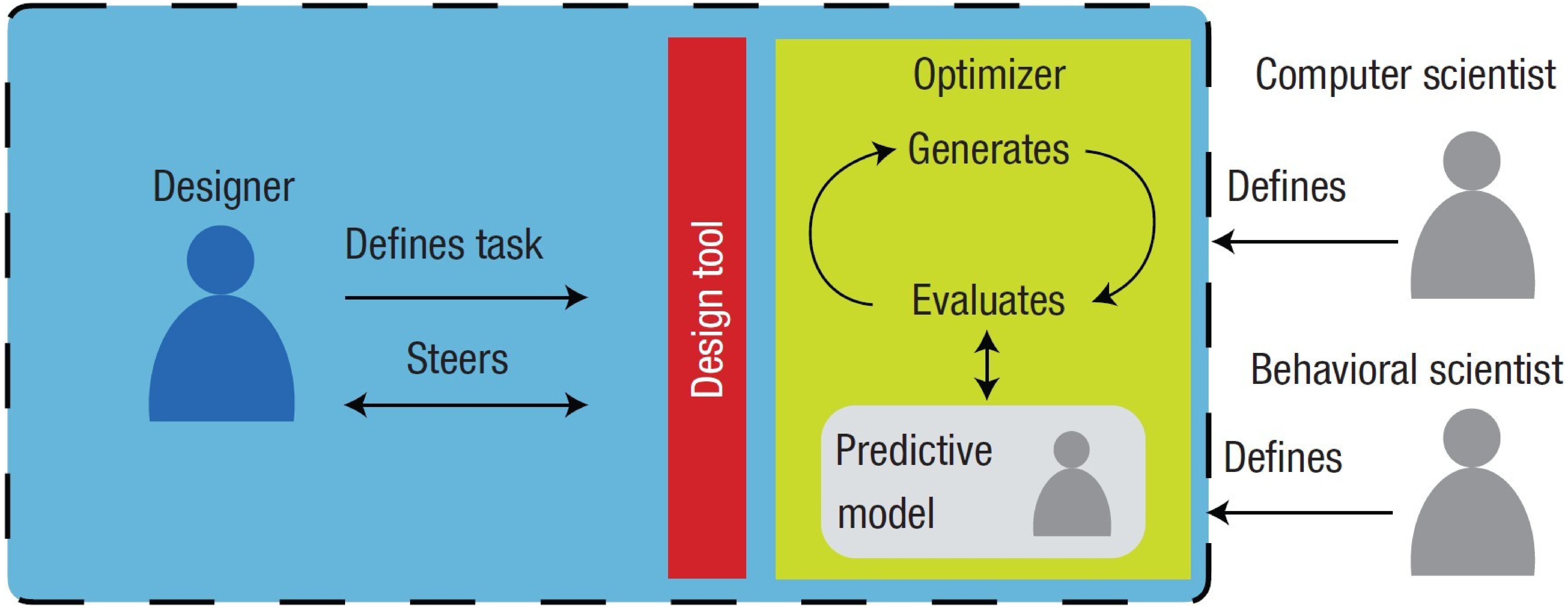


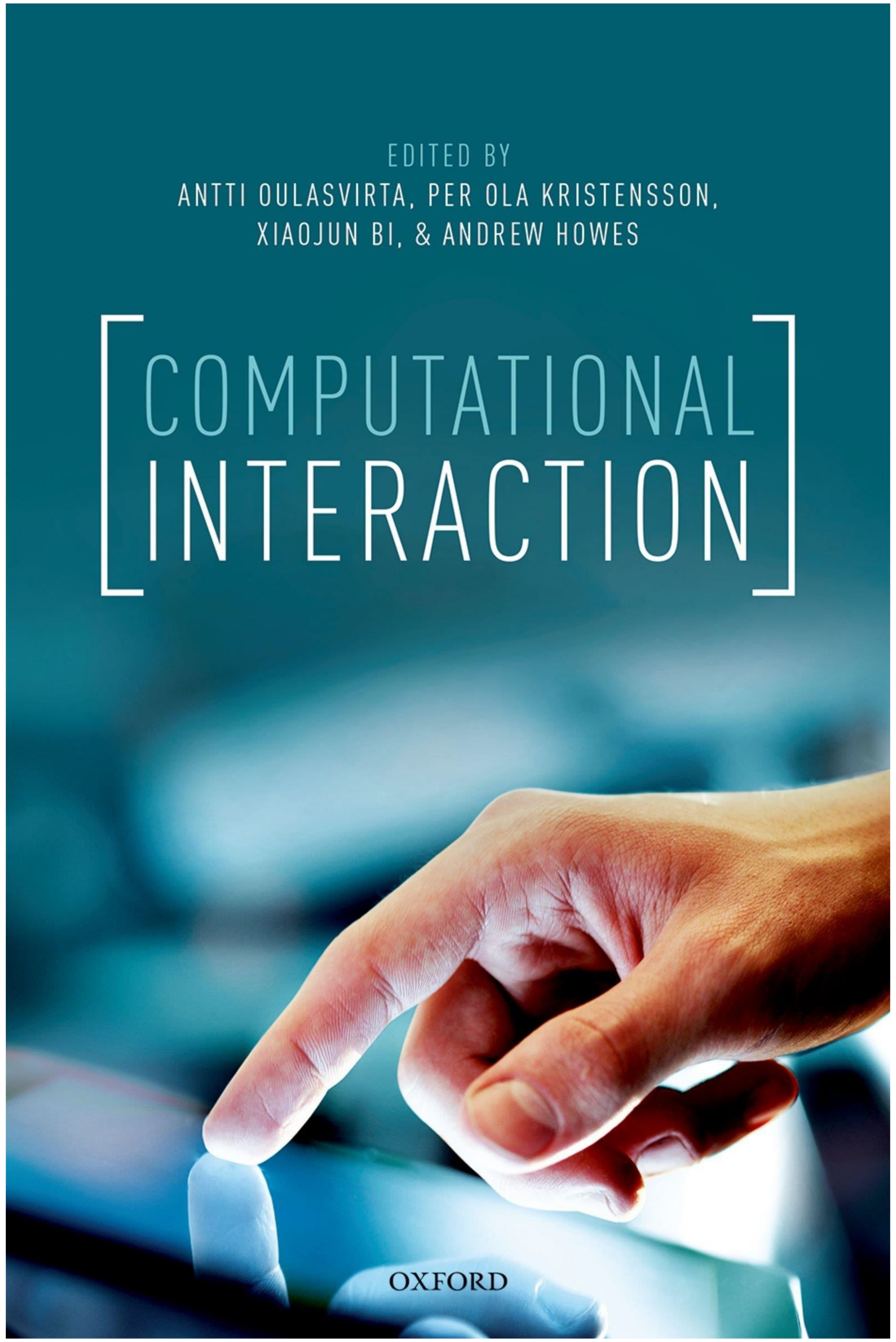
Components:

- Predictive model
- Optimization
- **Interaction with Designer**

Defining, Steering, recognising on the wrong track

People are often better at recognising than specifying good designs





Does this supersede waves 1-3?

Computational **Self-Determination Theory**?

Some aspects of SDT theory are not clearly enough specified for computational models: researchers in HCI are working to formalise them via modelling and simulation.

This includes modelling competence satisfaction during activities with reinforcement learning models.

Why Self-Determination Theory Needs Formal Modelling: The Case of Competence and Balanced Challenge

Sebastian Deterding[1*], Christian Guckelsberger[2,3], Erik M. Lintunen[2], Nadia M. Ady[2]

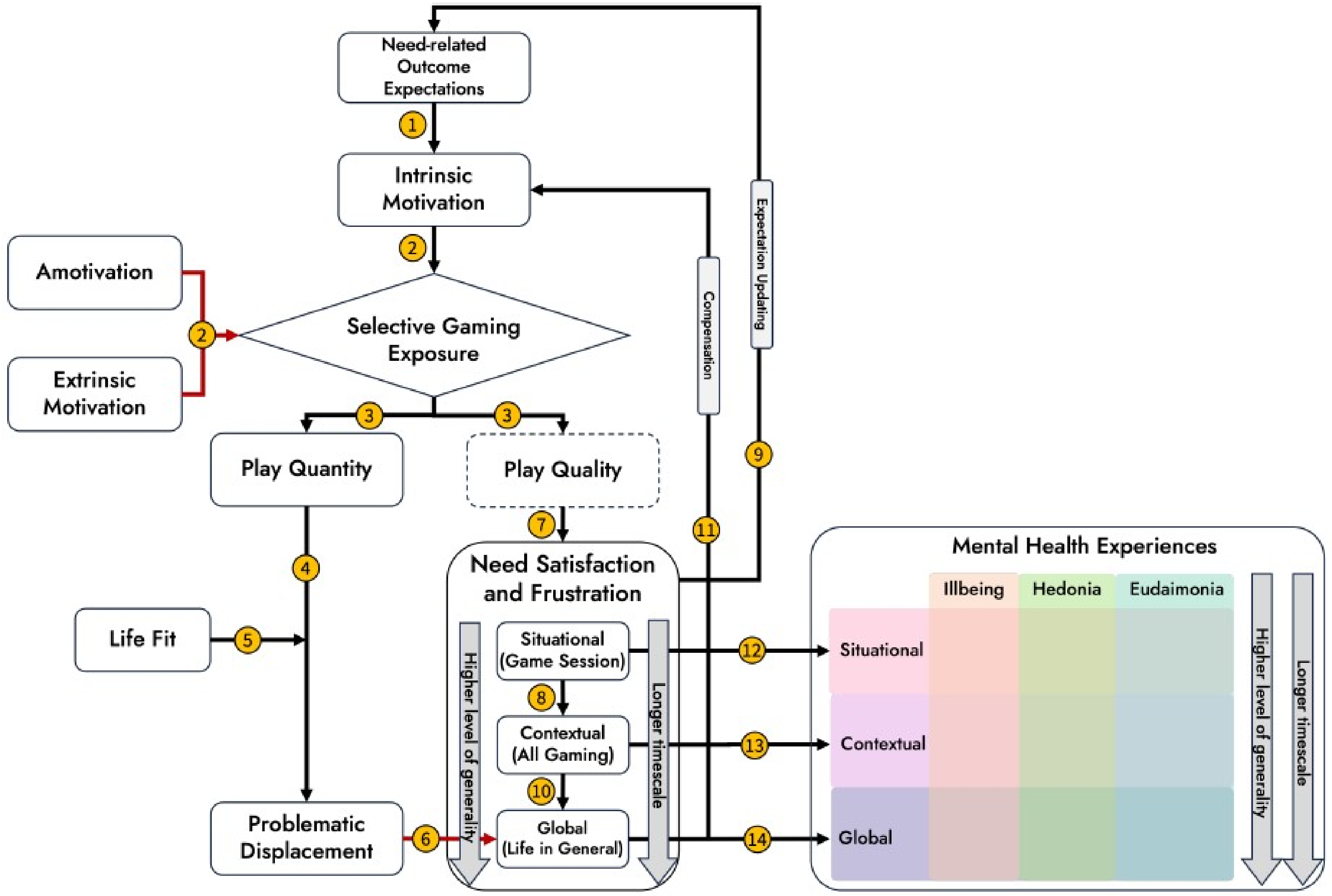


Figure 2: Overview of the Basic Needs in Games (BANG) model of video games and well-being. Black lines indicate positive relationships, and red lines indicate negative relationships.

Computational
Self-Determination Theory?

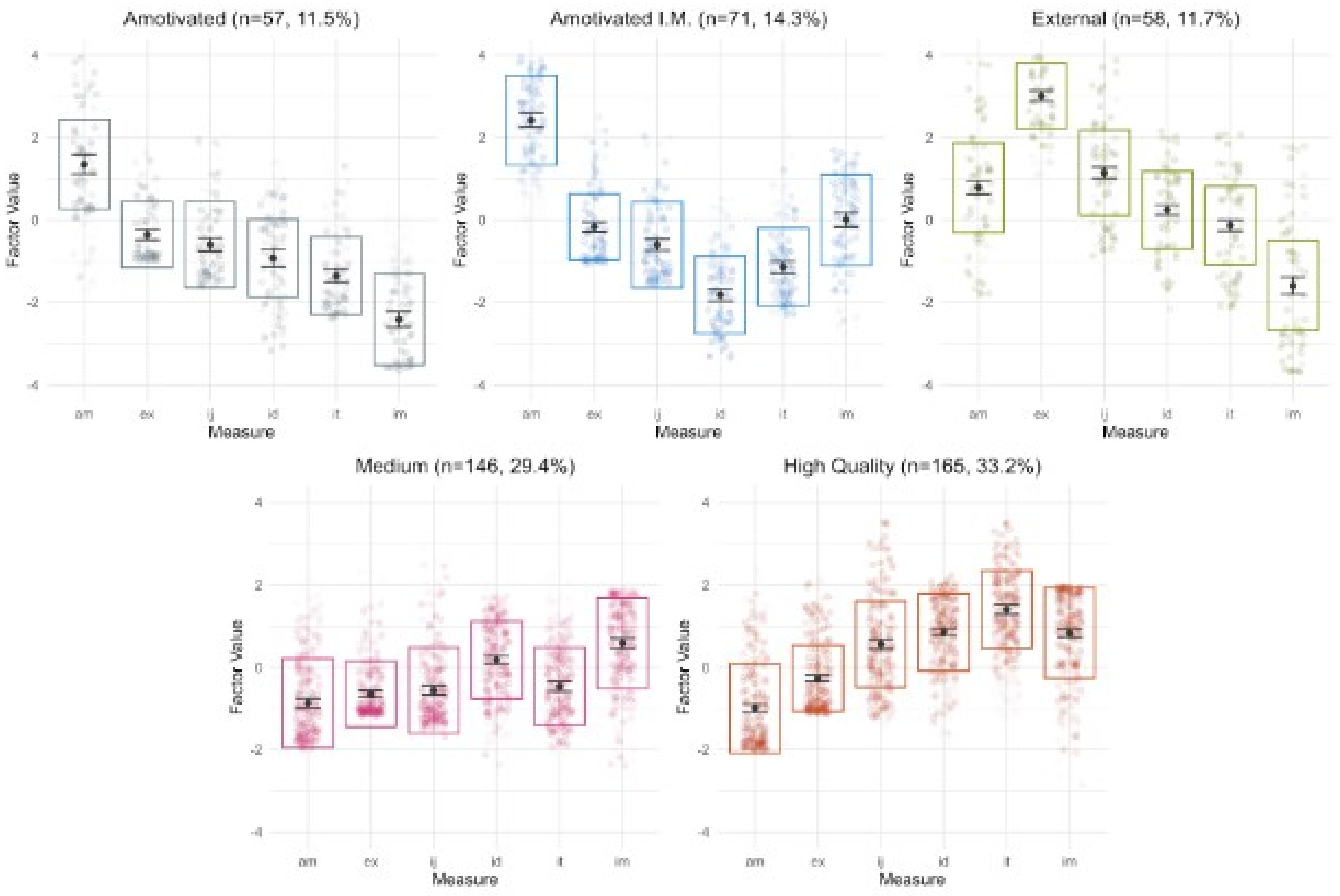
Extrinsic motivation in SDT is relatively complex compared to Intrinsic motivation

We used machine learning approaches to identify distinct motivational profiles in user populations. These seem to predict healthy and unhealthy patterns of engagement

Beyond Intrinsic Motivation: The Role of Autonomous Motivation in User Experience

DAN BENNETT, University of Bristol, UK
ELISA D. MEKLER, IT University of Copenhagen, Denmark

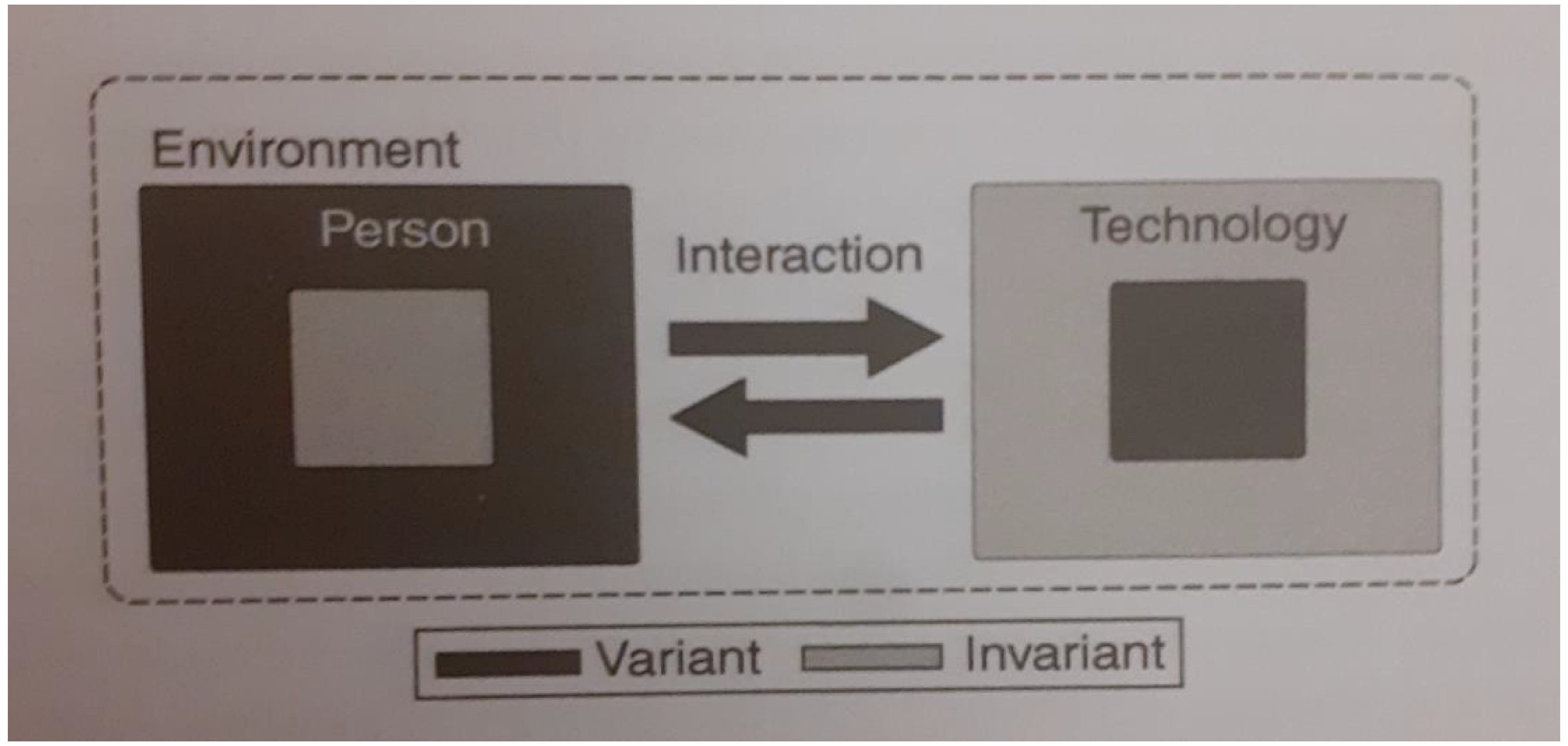
Motivation and autonomy are fundamental concepts in Human-Computer Interaction (HCI), yet in User Experience (UX) research they have remained surprisingly peripheral. We draw on Self-Determination Theory (SDT) to analyse autonomous and non-autonomous patterns of motivation in 497 interaction experiences. Using latent profile analysis, we identify 5 distinct patterns of motivation in technology use — "motivational profiles" — associated with significant differences in need satisfaction, affect, and usability. Users' descriptions of these experiences also reveal qualitative differences between profiles: from intentional, purposive engagement, to compulsive use which users themselves consider unhealthy. Our results complicate exclusively positive notions of intrinsic motivation, and clarify how extrinsic motivation can contribute to positive UX. Based on these findings we identify open questions for UX and SDT: addressing "hedonic amotivation" — negative experiences in activities which are intrinsically motivated but not otherwise valued — and "design for internalisation" — scaffolding healthy and sustainable patterns of engagement over time.



Computational
Situated action?

Remember **situated interaction?**
Readiness-to-hand?
Distributed Cognition?

Are the boundaries between inner and outer so clearly defined and so definite?



Computational

Situated action?

Is there always a neat separation between people and their environments?

Can we go beyond intuition, to model and observe this?

Next Steps in Human-Computer Integration

Florian 'Floyd' Mueller [1], Pedro Lopes [2], Paul Strohmeier [3], Wendy Ju [4], Caitlyn Seim [5], Martin Weigel [6], Suranga Nanayakkara [7], Marianna Obrist [8], Zhuying Li [1], Joseph Delfa [1], Jun Nishida [2], Elizabeth M. Gerber [9], Dag Svanaes [10], Jonathan Grudin [11], Stefan Greuter [12], Kai Kunze [13], Thomas Erickson [14], Steven Greenspan [15], Masahiko Inami [16], Joe Marshall [17], Harald Reiterer [18], Katrin Wolf [19], Jochen Meyer [20], Thecla Schiphorst [21], Dakuo Wang [22], Pattie Maes [23]

Figure 1. Exemplars of Human-Computer Integration: extending the body with additional robotic arms; [71] embedding computation into the body using electric muscle stimulation to manipulate handwriting [49]; and, a tail extension controlled by body movements [87].

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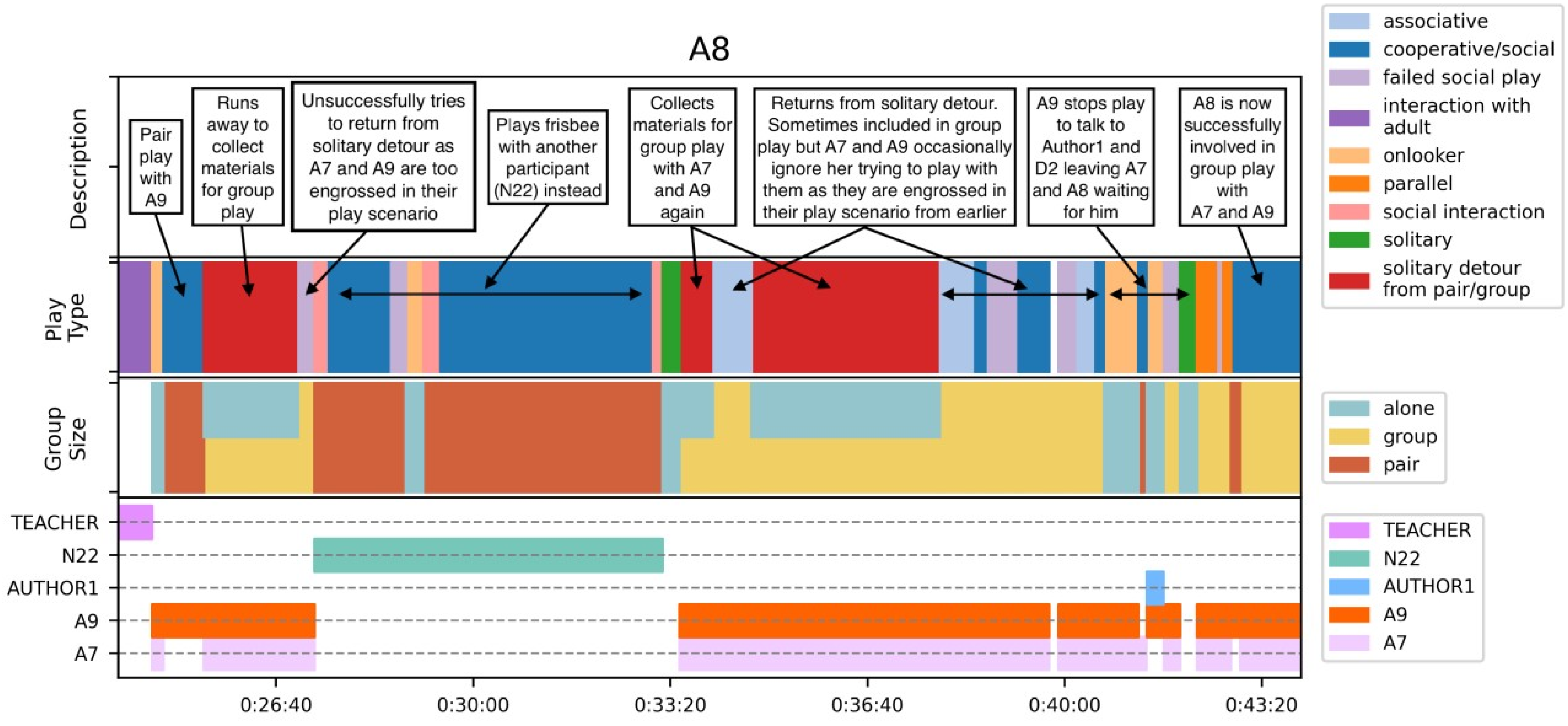
Computational
Situated action?

How can we model and understand complex situated interactions?

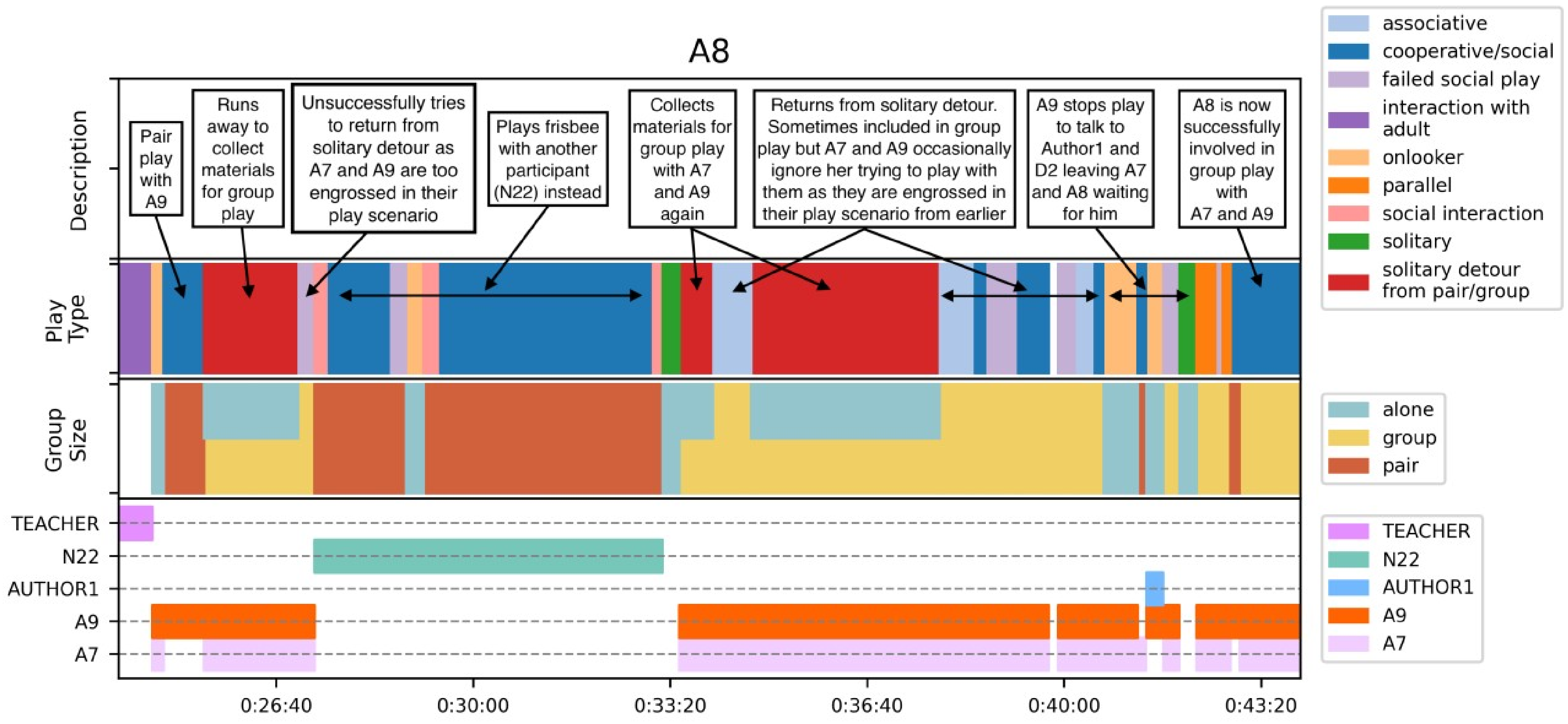
Play between autistic and non-autistic children: how do we have technologies understand and adapt to children’s coordination patterns?

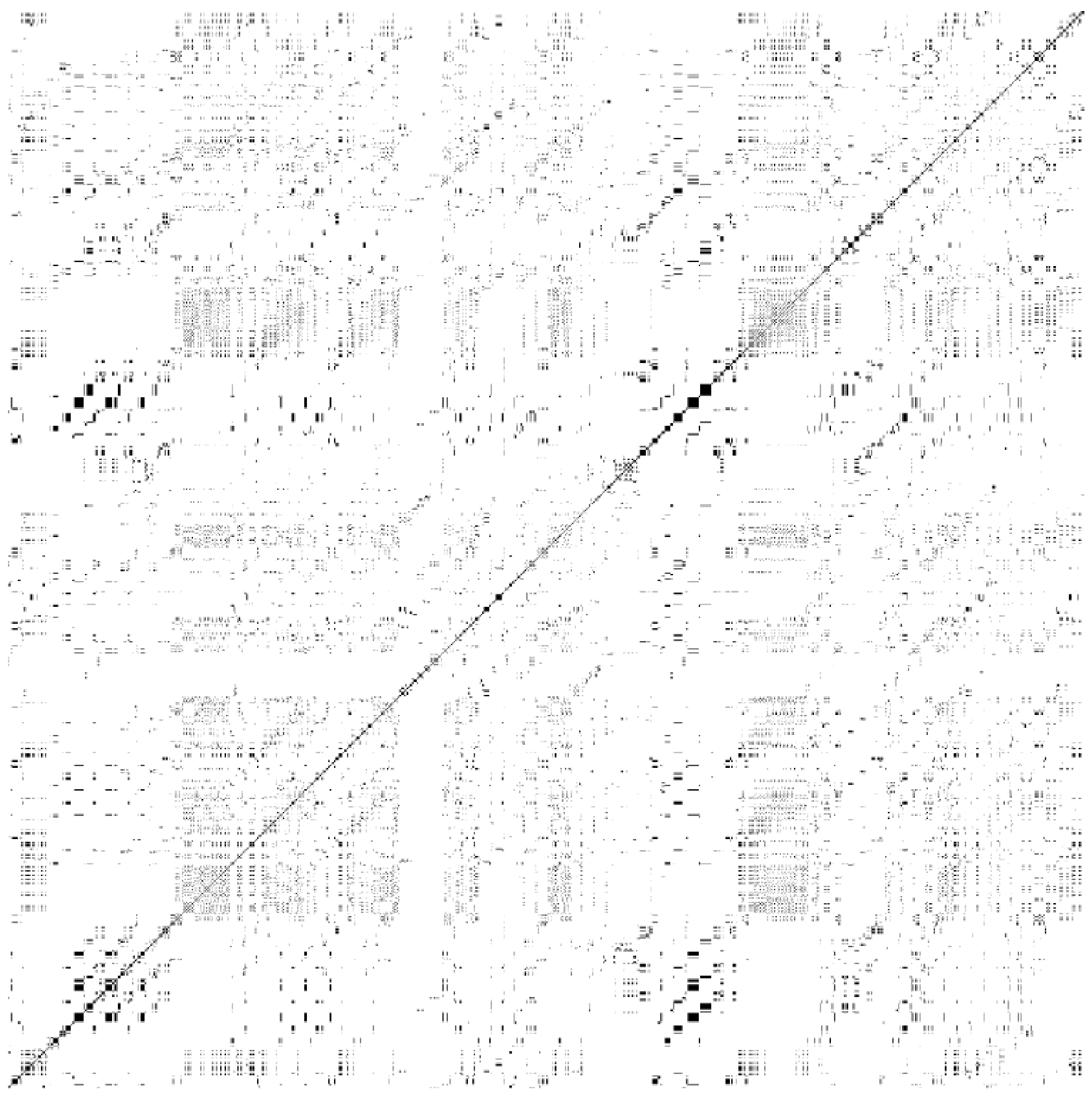
(a) Indoor Play

(b) Outdoor Play



Computational
Situated action?





Recurrence Quantification Analysis

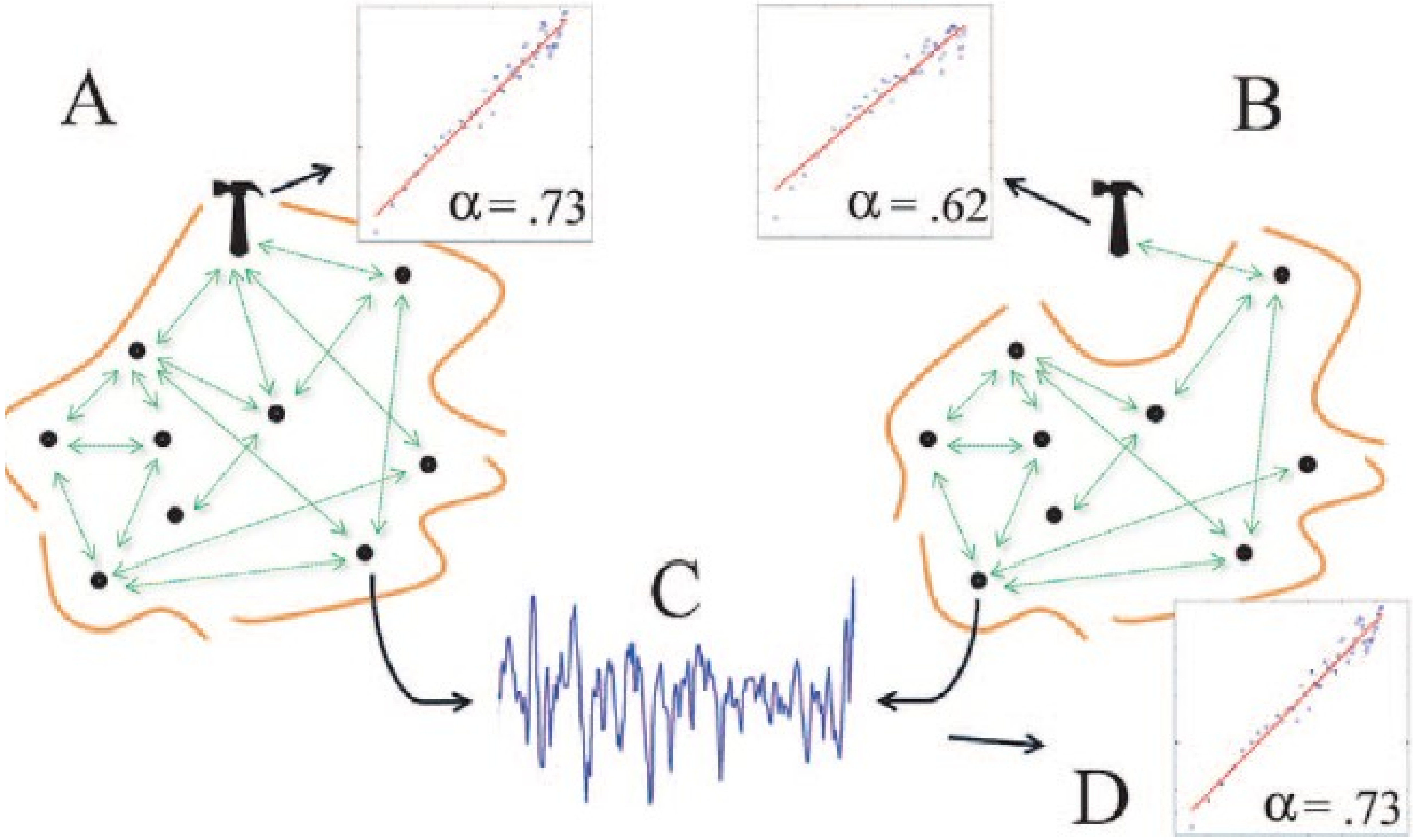
A mathematical approach to analysing complex coordination patterns in behaviour?

Can we use metrics of complex patterning to identify positive interactions and help support them? Can we identify breakdowns in play and coordination?

Computational
Readiness-to-hand?

Integrated tool (ready to hand)

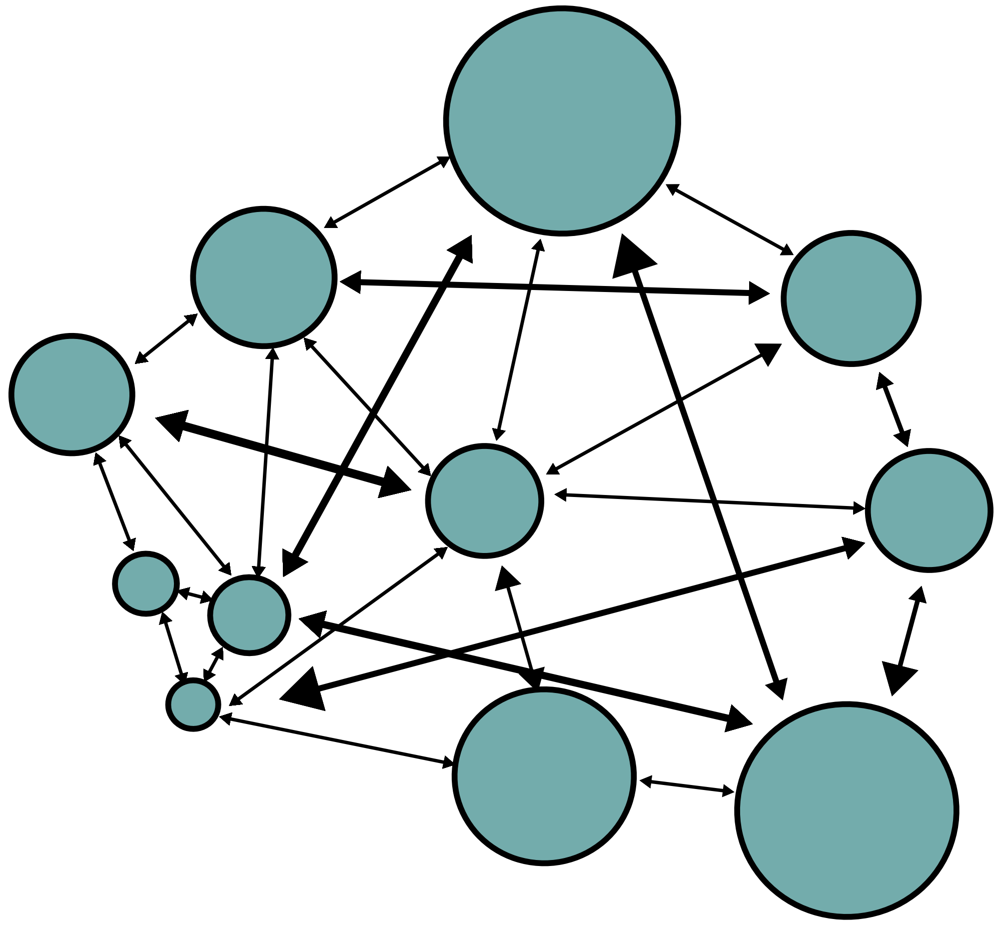
Non-integrated tool (present-at-hand)



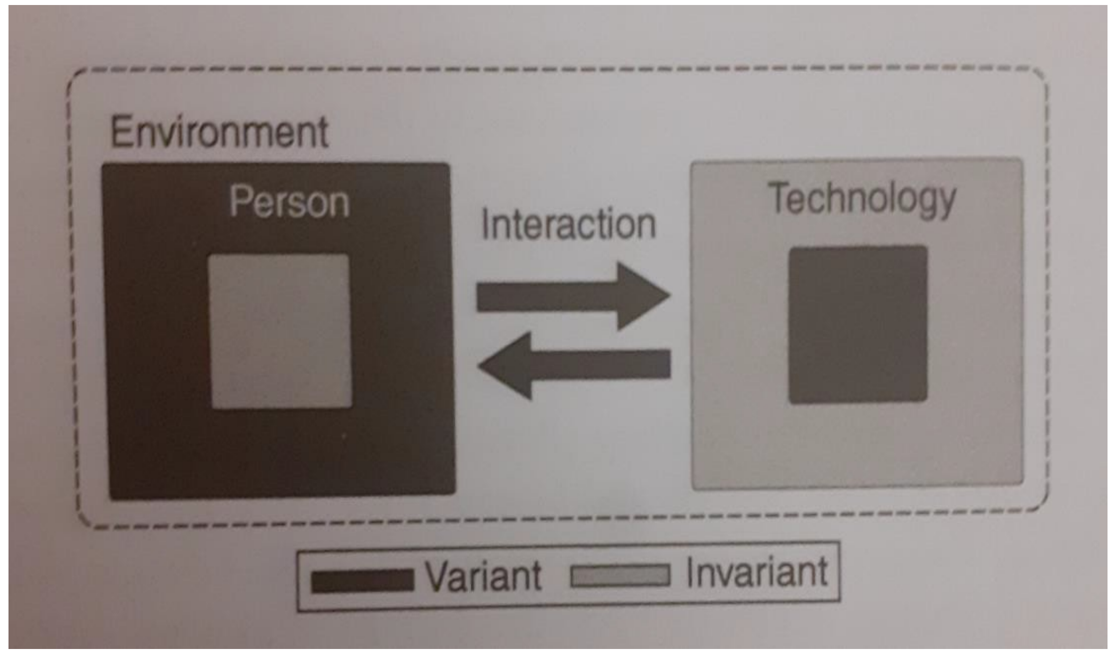
The shift from “ready to hand” to “present at hand” can be seen as a shift

away from “embodied” coordination (e.g. situated action)

towards more centrally organised behaviour (closer to computational models)

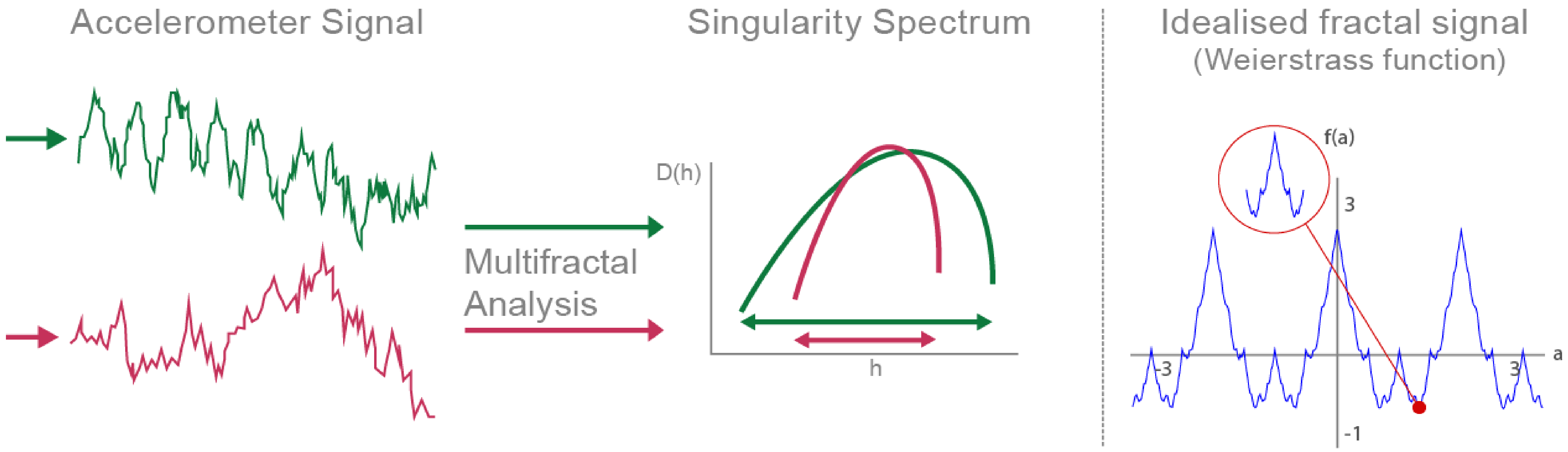


Interaction Dominant



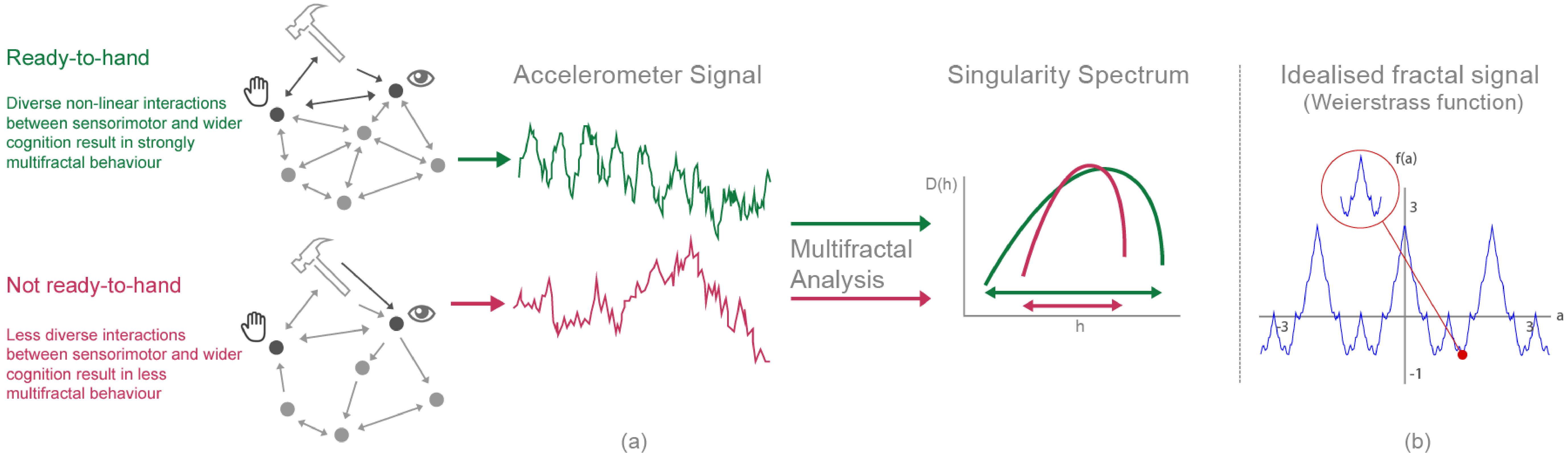
Component Dominant

Complex networks produce "multifractal" signatures in movement



(a) (b)

Neatly separated networks produce weaker multifractal signatures



We observed this effect in mouse-use experiments, by simulating breakdowns in the mouse

We're now applying the approach to understand patterns in experience with videogames

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