

Impact case study (REF3)

Institution: University of Edinburgh		
Unit of Assessment: 30 (Philosophy)		
Title of case study: Distributed cognition: Inspiring technological design, influencing cultural organisations and artistic practitioners, and stimulating public discourse		
Period when the underpinning research was undertaken: 2008 – 2020		
Details of staff conducting the underpinning research from the submitting unit:		
Name(s):	Role(s) (e.g. job title):	Period(s) employed by submitting HEI:
Andy Clark	Professor of Logic and Metaphysics	Aug 2004 – Dec 2018
Dory Scaltsas	Professor of Ancient Philosophy	Oct 1984 – Jul 2018
Mark Sprevak	Senior Lecturer	Jan 2011 – present
Period when the claimed impact occurred: August 2013 – December 2020		
Is this case study continued from a case study submitted in 2014? N		
1. Summary of the impact		
<p>One of the greatest scientific challenges today is to uncover the physical mechanisms responsible for human thought and feeling. Distributed cognition holds that those mechanisms do not always lie inside the brain; sometimes they include processes in the body, environment, and in technological tools such as smartphones. Edinburgh researchers have defended this idea and explored its consequences for wider society.</p> <p>This research has influenced industrial product design, as demonstrated by testimony of industrial researchers at Google and CyborgNest; influenced cultural organisations and artistic practitioners, as demonstrated by commissioning of a new EUR2.5M Museum of Ideas in Athens and dedicated exhibitions around the world; and changed public discourse on human–technology relationships, as demonstrated by engagement within mainstream media, user-generated blogs, and with professional journalists.</p>		
2. Underpinning research		
Key research insights which have led to specific impacts since August 2013 are outlined below.		
The extended mind		
<p>Clark, a pioneer of distributed cognition, joined Edinburgh in 2004. His 2008 monograph <i>Supersizing the Mind</i> provided a landmark development of work in this area [3.1]. The core insight is that thinking can happen outside the brain. Clark’s book opens with the observation that it can sometimes feel like one’s mind is partly “on” one’s smartphone. He goes on to argue that, in an important and literal sense, this claim is true. Our mental states and processes are realised by a mixture of brain-based mechanisms and extended, external resources encompassing bodies, technology, and other people. The precise mixture, and the degree to which our brain figures in it, varies over time and depends on the task demands. <i>Supersizing the Mind</i> not only defends this theory by answering critics’ most common objections, but expands it by incorporating technological, experimental and analytic developments since the original 1998 Clark and Chalmers article “The extended mind” (<i>Analysis</i> 58/1), and explores the relevance of the thesis for additional processes (e.g. willpower, emotion, imagination, and consciousness).</p>		
Embodied predictive processing		
<p>Clark’s research on embodied predictive processing aims to show how recent neural-network based models of cognition relate to the idea that cognition is embodied and distributed in the world [3.2, 3.3]. Work on the predictive brain reveals a continuous self-organizing process (governed by the drive to minimize neuronal prediction error) that sweeps together bodily action,</p>		

mental action, and the use of bio-external props and tools, holding it all together in a kind of bio-techno-social swirl. In this way, Clark's work on the predictive brain shows, for the first time, exactly **how and why our tools and technologies come to function as extensions of (indeed, elements of) the human mind**. This work also shows how what appears, at first glance, to be a brain-based theory can support, and in certain cases requires, distributed cognition.

History of distributed cognition

Sprevak's work aims to show not only how distributed cognition has a history (it was accepted or rejected in various historical periods), but also how historians can benefit from using the ideas of distributed cognition to connect history of ideas to the material culture of the time. The key insight – which has been of particular relevance to museums and art galleries – is that **historical artefacts can be understood as inextricably tied to certain forms of cognition** in a similar sense as devices like smartphones are conceived in Clark's framework. Ceramic tiles found in Roman barracks with scratched nested lists are evidence of new styles of thinking and problem solving among commanding officers [3.4]; twentieth-century surrealist techniques like *decalcomania* reveal artistic assumptions about how creativity depends on external and unconscious factors [3.5]. This work has brought together an interdisciplinary team of over 40 historians, anthropologists, literary theorists, and museum curators, to publish a multi-volume series on ways in which distributed cognition can interact with the humanities. In a separate project, **Scaltsas** applies the link between artefacts and thought to the history of philosophy, by focussing on the ways in which ancient Greek ideas and values (e.g. democracy) are partially embodied in material objects (e.g. voting ballots) [3.6].

3. References to the research

- [3.1] **Clark, A.** (2008). *Supersizing the Mind: Embodiment, Action, and Cognitive Extension*. Oxford University Press. <https://doi.org/10.1093/acprof:oso/9780195333213.001.0001> (can be supplied by HEI on request)
- [3.2] **Clark, A.** (2013). Whatever next? Predictive brains, situated agents, and the future of cognitive science. *Behavioral and Brain Sciences*, 36(3), 181–204. <https://doi.org/10.1017/S0140525X12000477>
- [3.3] **Clark, A.** (2016). *Surfing Uncertainty: Prediction, Action, and the Embodied Mind*. Oxford University Press. <https://doi.org/10.1093/acprof:oso/9780190217013.001.0001>
- [3.4] Anderson, M., Cairns, D., & **Sprevak, M.** (Eds.) (2018). *Distributed Cognition in Classical Antiquity*. (The Edinburgh History of Distributed Cognition Series; Vol. 1). Edinburgh University Press (can be supplied by HEI on request).
- [3.5] Anderson, M., Garratt, P., & **Sprevak, M.** (Eds.) (2020). *Distributed Cognition in Victorian Culture and Modernism*. (The Edinburgh History of Distributed Cognition Series; Vol. 4). Edinburgh University Press (can be supplied by HEI on request).
- [3.6] **Scaltsas, T.** (2018). Extended and embodied values and ideas. In D. Sfendoni-Mentzou (Ed.), *Aristotle – Contemporary Perspectives on his Thought: On the 2400th Anniversary of Aristotle's Birth* (pp. 167–178). de Gruyter. <https://doi.org/10.1515/9783110566420-010> (can be supplied by HEI on request)

4. Details of the impact

Influenced industrial product design

In 2018, as a result of the media coverage of his work, Clark was approached by the Principal Designer at **Google LLC**, whose team “research, develop and inform a range of different Google products and technologies” [5.1]. Clark began a six-month period of consultancy (the first philosopher the group had ever worked with), working with a team of approximately 50 international Google staff on the future of AI assistants. While the details of the work and its impact on specific future Google commercial offerings cannot be shared due to a non-disclosure agreement, the Principal Designer notes that Clark's research, including *Supersizing the Mind*

and *Surfing Uncertainty* “directly impacted on how we frame problems, and changed our future research agenda within Google” [5.1]. He gives an example of how Clark’s research led them to shift their perspective from a technological solution where everything is routed through a single entity, to one where the solution is “mediated through multiple entities that work together as a form of Extended Mind” [5.1]. The Principal Designer also commented, with regard to his own thinking, that “I found Clark’s research impacted my own practice by changing the way I respond to ideas around AI” [5.1]. As a result of the consultancy, Clark and the team co-authored 3 internal essays which were circulated within Google receiving feedback and prompting “internal conversations and new perspectives well beyond our team, engaging approximately 100 Google staff from across UK, USA, Europe” [5.1]. The team also created a 2-minute animation to share Clark’s research with a general internal audience at Google that “stimulated new discussion and ideas” within the company [5.1]. The Principal Designer reported that Google intends to continue to “benefit from [Clark’s] expertise and insights” [5.1].

Also in 2018, Clark was approached by London-based start-up **CyborgNest Ltd** (9 employees in 2019, 11 employees in 2020 according to LinkedIn). CyborgNest uses technology to try to create new human senses. Their first product, North Sense, was a miniaturized circuit board that attaches to the wearer’s chest and vibrates when it faces north. North Sense was originally intended to be only a “proof of concept that ‘body-hacking’ technology could provide the user with sensory information about an entirely new (to humans) sense” [5.2]. However, the initial product run sold out – selling several hundred devices (compared to an anticipated 10–20), and generating approximately USD85,000 of income for CyborgNest. North Sense received widespread media coverage, including features in *The Guardian*, *Le Monde*, *Wired*, and BBC Radio 4’s *Meet the Cyborgs*. The co-founder and CEO confirms the impact of Clark’s work both on their decision to develop their product idea and on the product’s final design [5.2]:

“Over the past 2-3 years, I have read widely around Clark’s research, including *Surfing Uncertainty*, *Supersizing the Mind* ... Clark’s approach to the extended self and human-technology interactions ... gave us the confidence to go forward with our ideas and develop new products” [5.2]

“In developing the chip, we drew explicitly on Clark’s research and the notion of the Extended Self. Our aim was to create a product that would act as an extension of the user, and simply give vital information within your life, just like any other sense organ. Clark’s work on Extended Self (e.g. in *Supersizing the Mind*) was one of the reasons why we decided against the use of a technology interface such as a screen or buttons” [5.2]

Feedback from customers was “extremely positive” with users reporting that “they actually feel more human, rather than that they are turning into a machine” [5.2]. Following the success of North Sense, Clark was appointed to the company’s advisory board, and has been instrumental in developing new products [5.2].

Influenced cultural organisations and artistic practitioners

In 2016, the Greek Minister for Culture was present at two research talks given by Scaltsas (at the Aristotle-2400 Conference in Thessaloniki and at the Demokritos National Research Centre in Athens). In this work (published in [3.6]), Scaltsas applied Clark’s ideas about distributed cognition (as developed in *Supersizing the Mind*) to the Aristotelian conception of external goods, and argued that abstract ideas should be understood as partially embodied in physical objects. On the basis of these talks, the Greek Minister invited Scaltsas to develop a proposal for a Museum of Hellenic Ideas that would explore “how ideas, being abstract, could nevertheless be exhibited” by using objects that embody a culture’s values [5.3]. In 2019, as a direct result of Clark and Scaltsas’ research [3.1, 3.6], the Greek Government formally began work on a **new museum displaying Greek ideas**, funded by EUR2,500,000 from the EU Innovative Projects Fund. The museum, to be sited at Aristotle’s *Lyceum*, represents not just a new museum building and exhibits, but also a change in Greek government policy on promoting ancient Greek civilisation [5.4]: “This is the first time that the Greek Ministry of Culture included in its cultural

policy for the promotion of the ancient Greek civilization the exhibition of the ideas of the ancient culture” [5.3].

In 2015, Tokyo-based robotics researchers and artists created **Alter**, an android whose design and algorithm they say “draws directly on Clark’s research about the offloading of agency into the environment” including “Clark’s unique concept of the environment itself constituting the algorithm behind consciousness and agency” (citing [3.1, 3.3]) [5.5]. A subsequent collaboration with composer Keiichiro Shibuya featured **Alter** as conductor of a live orchestra in a specially commissioned opera, *Scary Beauty*, in which the robot’s conducting movements were regulated by the environment in the ways described by Clark. Since 2018, **Alter** has performed *Scary Beauty* in Germany, Japan, and the UAE, and has received more than 40,000 views on YouTube (as of December 2020). In 2019, **Alter** featured in the *AI: More than Human* exhibition at London’s Barbican, which attracted 93,000 visitors [5.5].

In 2018, Berlin-based curator Alice Hinrichs developed the 3-day **Arte Luce** light installation shown at Alte Münze as a direct response to Clark’s work on the extended mind, citing that *Surfing Uncertainty*, “strongly influenced the exhibition and the briefing [the curator] gave to artists” [5.6]. The installation featured 10 specially commissioned site-specific artworks which “drew on the notion of our external environment acting as an extension of our cognitive architecture”. Clark’s research was also shared and discussed with the exhibition’s 2,200 paying visitors via exhibition interpretation, guided tours, catalogue, and social media, and resulted in “overwhelmingly positive” visitor feedback, indicating “an increase in public knowledge of extended mind theory in Germany” [5.6]. The curator notes that Clark’s research has changed her professional practice more broadly: “Having encountered and worked with Clark’s research, I am more aware of the benefits of using a scientific theory both to allow artistic responses, and to draw the public in to experiencing light art. I have decided that future exhibitions will also be underpinned by scientific theories with links to technology” [5.6].

Based on their research on the history of distributed cognition, in 2019 Sprevak and colleagues created **The Extended Mind exhibition** at Edinburgh’s Talbot Rice Gallery (TRG), funded by a GBP100,000 AHRC follow-on impact award [5.7]. The TRG is one of Scotland’s leading public galleries of contemporary visual art, showing approximately 3 exhibitions per year, each costing approximately GBP150,000. *The Extended Mind* exhibition brought together 13 internationally renowned artists to explore how distributed cognition relates to contemporary art in a group show of 28 artworks. This was the TRG’s first exhibition based around academic research and the gallery’s Curator commented that it “enabled a collaboration free from many of the hierarchies and assumptions that often seem to be a reductive aspect of interdisciplinary collaborations involving artistic practice ... The distributed cognition research programme really enhanced our curatorial vision”. He observed that the research also “changed the way I understand my own work” including how he approached understanding and curating the works of artists in subsequent exhibitions [5.7].

The exhibition also influenced the thinking and practice of the exhibiting artists. **Marcus Coates** (winner Merrill Lynch Award 2013; Venice Biennale 2007), said: “All art exemplifies the extended mind. This wasn’t obvious to me before and it was a bit of a revelation to me... this will influence how I will think in the future about the creative mind and my own artistic practice” [5.7]. Paris-based performance artist, **Myriam Lefkowitz** (Venice Biennale 2013) said: “The research ideas in the context of the exhibition ... enabled me to access a different approach to thinking about how my work engages its fundamental themes” [5.7]. Tokyo-based mixed-media artist **Goro Murayama** (winner Shiseido prize 2010) noted that the “exhibition was made possible through the connection to the underlying academic research ... [it] enabled my work to be seen afresh” [5.7]. New York-based conceptual artist, **Agnieszka Kurant** (winner LACMA Art + Technology Award 2020; Frontier Art Prize 2019; Venice Biennale 2011) joined the group show because ideas about distributed cognition would help viewers better engage with her work on artificial intelligence and human intelligence [5.7]. From November 2019 to February 2020, 3,839 members of the public visited the exhibition with 80% reporting that they learned something new; 47% saying it changed the way they thought about the mind. Visitor comments included that it “inspired my personal research”; it was a “wonderful curation of a journey into thinking”; and it “prompted a discussion of the relation between thinking and art” [5.7]. The exhibition attracted 18

print or online articles including in *The Times* (14,975,000 monthly readership), New York-published *Studio International* (more than 200,000 readers a month, over 4.5 million page views a year), and *a.n* (the artists' information company, 38,500 users/182,000 page views per month) [5.7].

Influenced public discourse around human–technology relations

High-profile public talks (e.g. New Scientist Live, How the Light Gets In) by Clark, and the relevance of his research to how we conceive of how humans interact with technology, has brought his work to **widespread media attention** [5.8]. International audiences have gained increased awareness of distributed cognition from coverage of Clark's ideas on television (PBS's *Closer to Truth* – airs on more than 200 PBS stations in USA; 47,045 YouTube views of Clark's clips as of December 2020); radio (ABC national radio in Australia; CBC national radio in Canada; BBC Radio 4's *The Learning Revolution* – collective monthly listenership 48M); and podcasts (*Philosophy Bites*; *Brain Science*; *New Books Network*; *Edge Foundation*; *TEDx* – combined over 100,000 downloads of Clark's podcasts). Clark's work has been discussed in print in *The New York Times*, *The New Yorker*, *The Times Literary Supplement*, *Wired*, *Business Insider*, *Slate*, *The Economist* [5.8].

This media coverage generated **online public discussion** of these topics. The newspaper articles generated over 10,000 views and over 700 social media interactions or comments [5.7]. Readers of the profile of Clark in *The New Yorker* tweeted that “This is so fascinating and made my brain light up” and “this one blew my mind” [5.8]. Other readers went further by generating their own content on subreddits (online communities on the website Reddit dedicated to a particular topic) and blog posts, resulting in over 5,000 direct engagements with Clark's research by readers who wished to discuss its relationship to architecture, autism, drugs, physiotherapy, meditation, and robotics [5.8].

Clark's research has also helped shape the way **journalists** think about and present these ideas to the public. Larissa MacFarquhar, author of the 10,000-word profile of Andy Clark in *The New Yorker* – where she has been a leading staff writer since 1998 and whose other profile subjects have included Barack Obama, Noam Chomsky, and Hilary Mantel – commented, “Before writing about Andy Clark, I thought that I could avoid the subject of technology. But now having read his work, I realize that to ignore the way that I and everyone else are being transformed by our devices is to miss one of the most important intellectual stories of our time” [5.9].

5. Sources to corroborate the impact

- [5.1] Testimonial from Google AI Principal Designer
- [5.2] Information from CyborgNest CEO and media coverage of North Sense project
- [5.3] Statement from former EU funding and project coordinator, Greek Ministry for Culture, 2017
- [5.4] Greek government documentation confirming funding and start of museum project (document in Greek)
- [5.5] Testimonial from *Alter* creator and information on *Alter*'s reach
- [5.6] Statement from *Arte Luce* curator, 2019
- [5.7] *The Extended Mind* exhibition engagement and impact overview, University of Edinburgh 2020.
- [5.8] Clark and human–technology relations: collection of discussions and coverage
- [5.9] Statement from *The New Yorker*'s journalist