THE SYMBOLISM OF UBIQUITOUS COMPUTING TO NEUROPSYCHIATRISTS

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Prompt explanation *Introductory section taken from MA thesis. Shows primary research skills for developing and conducting independent project as well secondary research skills, i.e., how project is framed with respect to other primary research literature.*

The computer is the ultimate ethical machine. It has no actual relation with ideology in any proper sense of the term, only a virtual relation – Alexander Galloway, *The Interface Effect* (2011, p. 52)

Historically, psychiatrists have found it difficult to implement standards across their practices. The discipline of psychiatry has not developed the same type of coordination, shared metrics, or sense of "objective" clinical measurements that characterize the relative uniformity of other medical sciences.[1] Psychiatrists have faced the challenge of developing rigorous standards in quantifying measures of the psyche, the mind, the brain, cognition, affect or mood, which has fueled much of the development of psychiatry both as a disciplinary science and as a complex social institution (see Luhrmann 2001). Psychiatrists themselves are acutely aware of this status of psychiatry with respect to other clinical sciences. According to some orienting narratives that psychiatrists tell, the discipline has produced more viable standards in recent decades, from the development of the American Psychiatric Association's Diagnostic and Statistical Manual(s) (DSM) to current investigations based on spatial and temporal resolution improvements in neuroimaging. Even psychiatrists more critical of the field agree that these channels of clinical investigation and diagnosis have been relatively, but not totally, successful in coordinating practice and reducing the earlier "chaos" of psychiatry, neurology and psychoanalysis (Insel 2017) into common treatments and practice. As the knowledge, institutional influence, and apparent cultural prestige of the neurosciences grows (cf. Choudhury & Slaby 2012), recent neuroscience-led developments in genomic and precision medicine have attempted to set an agenda for new standards in psychiatric medicine (cf. Fernandes et al. 2017).

[1] Psychiatry's diagnostics were perhaps left behind by the discovery of the germ theory of disease. See Kapur et al. (2012).

One promising approach emerging in part from such work in neuro-psychiatry[2] aims to utilize now-ubiquitous personal technologies like smartphones to institute standard metrics and measurement for human behavior and cognition. These measurements would resemble medicine's pervasive biometrics, such as blood pressure or weight. As exemplified in the recent work of Harvard neuroscientists JP Onnela and John Torous, the concept of "digital phenotyping"[3] has gained strong institutional support as a viable, if not inevitable, direction of psychiatry in the "digital age". Psychiatrists and neuroscientists like Onnela and Torous have argued for the potential of ubiquitous computing technologies ("ubicomp", see Dourish & Bell 2011) to revolutionize measurement-based mental health care. With personalized developments in ubicomp, psychiatry can transform smartphones and mobile app platforms into "scopic" systems (Knorr Cetina 2003) to measure medical phenomena as other medical sciences have.[4] One resident psychiatrist I interviewed, Jack, offered that although the work of psychiatry ultimately depends on the patient's irreducible subjective self-evaluation, psychiatrists want objective measurements in order to coordinate, compare, collaborate and make more efficient their work on subjectivity across studies, disorders, practices, regions and disciplines. Researcher-developers in digital psychiatry engage themselves in a sort of entrepreneurship and

[2] These developments within psychiatry draw from earlier bodies of work in "ecological momentary assessment" or EMA. (Onnela & Rauch 2016, p. 1693). Other broader approaches in "mHealth", "digital health" or "digital medicine" are also influential for work in this field, particularly in generating capital and media speculation about such work. See also work by Lupton (2016, 2014) and Schüll (2016).

[3] Digital phenotyping is defined as the "moment-by-moment quantification of the individual-level human phenotype *in situ* using data from… personal digital devices… Although the ability to record real-time self-reported symptoms, objective measures of behavior and continuous physiology from millions of individuals was not the focus of NIMH's RDoC original conceptualization, the rapid recent expansion of smartphones and connected devices offers both a useful new tool and data streams." (Torous et al. 2017, p. 2)

[4] Onnela & Rauch (ibid., p. 1691) make comparisons to the inventions of both the telescope and the microscope: "although these predate the industrial revolution, both can be found in today's laboratories throughout the world and they remain at the center of our scientific endeavors. In a similar way, as scientists depend on these instruments for observing the natural world, most of us have come to depend on our smartphones as tools for organizing and navigating our daily lives."

technological speculation that primarily concerns itself with reformulating cultural (both professional and patient) relationships with health data and ubiquitous digital technology.

While there are a number of perspectives in anthropology, sociology and science and technology studies that could shed light on these interesting developments at the intersection of mental health and digital technology, I focus here on critical work done on algorithms, data, and computation in large part because of its latent interest to both social critique and current work in psychiatry.[5] This paper takes up the general position that, beyond the relationships between infrastructures and trust which are at the core of media and entrepreneurial presentations of digital health, the prevalence of digital technologies entails fundamental relationships between systems of care and technical accounting, and, additionally, between the mediation of conventions and that of so-called "black-boxes".

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According to a growing body of scholarship in science and technology studies, computational and algorithmic systems are increasingly structuring the rhythms, routines and practices of social and political life (e.g., Kitchin 2017, Chun 2011, Beer 2017, Gillespie & Seaver 2015, Galloway 2006). For many of these critical scholars, digital technologies are adopted too quickly and without time to carefully consider their economic or cultural consequences. Thus, computation gives the illusion of speed and sets unsustainable pacing of innovation. Further, by following this pace of adoption, people risk fetishizing interfaces and seemingly logical computational processes, which leads these technologies to exert unexpected

[5] In his discussion of neuro-philosophers and ethnographers of neuroscience, Langlitz argues that more interdisciplinary work is needed in science and technology studies in order to bridge discourses occurring in exclusively negative and positive epistemic modalities (2016).

power over the way they conduct their lives.[6] As we often see, these algorithms miss or erase the ways in which pervasive structural violence biases input data. Computational infrastructures might, for example, exacerbate the inequalities of an already-political human reality as a matter of: allegedly neutral inputs and outputs (O'Neil 2016, Kirkpatrick 2017), calculable financial interests (Pasquale 2015), a normative model of "self-improvement" (Lupton 2016), entirely arbitrary numbers (Van Dijk 2014), inescapable ratings systems (O'Neil 2016), or moral judgements of a user's personal character (Fourcade & Healy 2017). As Ziewitz notes, in critical approaches in the social sciences, heterogenous lists like this one tend to be treated as evidence, not of the diversity of cultural practices which might invoke computation, but of algorithms' widespread influence and complicity with the broader fabric of neoliberal and capitalist development projects (2015, see also Gillespie 2013). By some critical standards the "objective readings" of psychiatric patients' mental states enabled by smartphones appear to fit within patterns established by these social scientific critiques of computation. However, this type of analysis would fail to recognize the contextual production of technologies specific to psychiatrists' routine practices, the competing (if seemingly commensurable) large-scale institutional interests at stake in this technological development, and the peculiar type of leverage that psychiatrists are able to exert, at this point, over the ethical use of technology in collaborative projects with computer scientists.

To contextualize these critiques, it is important to note that not all social institutions have as readily accepted these tenets of digital infrastructure. In medicine in general and psychiatry in particular, the incorporation of such technologies has been slow and cumbersome, if not

[6] Others have offered more precise reviews of critical anthropological and sociological work done on algorithms (e.g., Ziewitz 2015, Kitchin 2017).

inconsistent and controversial. Indeed, like anthropology,[7] the interpretive science of psychiatry was for a long time rhetorically contrasted with the image of computer programmers who perform closed-off, reductionist, cold logic incommensurate with the depth and breadth of human experience.[8] Despite the promised savings for an expensive and overburdened healthcare system, American psychiatrists have historically tended to take a more cautious stance toward the use of some of these technologies which appear to lack the appropriate context and immediacy for care. In other words, psychiatrists treated computer mediation like many other interpretive disciplines have—as a highly mediated form of communication or interpretation. According to neuropsychiatric scientists now deploying such technologies in their practices, the problems involving social relationships with technology are somewhat reversed from what is assumed in most contemporary social science accounts of the expansion of digital technology. Within these medical research discourses, both professionals and the public have hesitated to adopt these technologies. Entrepreneurial psychiatrists and their collaborators might succeed, however, if they invest in public relations, technological development and patient-centered policies which can inspire an authentic public trust in digital health technologies.

Indeed "trust" is cited by psychiatrists as an explicit problem in producing technologies and platforms for digitally-based psychiatry (Torous & Roberts 2017, Torous 2016). Entrepreneurial psychiatrists develop these technologies for research and clinical purposes to make study participation, diagnostic evaluation and (eventually) care easier for both patients and themselves. Insofar as these technologies symbolically, if not technically, function to some extent as stand-ins for psychiatric evaluations, physicians are concerned with broader cultural

[7] See Paul Kockelman's insightful analyses of how information and computer science served as a foil for the claims of a contemporaneously developing linguistic anthropological account of meaning (2014, 2013).
[8] See Luhrmann (2001, p. 231) and Montgomery (2006) This skepticism of psychiatric technologies also runs powerfully through the sociological literature (cf. Orr 2012).

understandings of and relationships with these technologies. In talks on digital medicine, physicians also generally stress the significance of a broad "culture" related to technology, health and information, a "culture" which is shared amongst medical professionals and patients alike (e.g., Insel 2017, Friend 2014, Chandra 2016). These physicians address their responsibility to be careful about, and even *to care for*, people's trust in responsible research and data practices. Practicing psychiatrists and other physicians appear to commit themselves to coordinating already-existing technologies, simplifying them and making them transparent (Torous et al. 2016). It is a radical innovation that is not so much premised on future expectations of improved transistor functioning or processing speed,[9] as it is on the reformulation of cultural relationships with particular technologies, data practices and forms of computer mediation. Psychiatrists understand their technological projects to be precarious such that any high-profile failure would mean a costly disaster for the *patient perception* of the whole field (e.g., Insel 2017, Swaminathan & Premalatha 2016), drastically diminishing the future possibility of enlisting digital technologies in mental health services.

This paper focuses on some of the technical and entrepreneurial development of a smartphone app at a neuropsychiatric laboratory at a major research-based university in the Midwest United States. The app, which I refer to as "Persephone", was intended as a tool to connect already-diagnosed bipolar patients with their physicians for clinical research and therapeutic purposes.[10] The Persephone project aimed to create a better monitoring system for patients that could help predict the timing and severity of manic and depressive episodes based

[9] Though also see Cyrus Mody's discussion of the cultural formulations of "Moore's Law" (2015) and its bias for applied research over basic research in corporate culture—which digital health and medicine certainly inherits.
[10] To be eventually marketed as health device. Its use in the pilot study could not be considered such. The FDA has a rather complex procedure for authorizing healthcare and medical technologies that go beyond research purposes. (USFDA 2017)

on how a patient was using her phone. The app would send metadata constructed from the phone's keyboard and accelerometer sensors directly to the physician's servers in order to help in patient health and pharmaceutical assessments and to generate talking points for conversations between physician and patient. Later, however, as the app made it through several rounds of a non-profit-sponsored venture funding contest, the researchers began to think of their work in terms of a broader digital platform for real-time monitoring of cognition for a variety of clinical and non-clinical purposes.

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Ethnographic and historical analyses of technologies have made a strong case for the codependence of categories like 'natural' and 'social', the irreducibility of "sociotechnical collectives",[11] and the interweaving of material things and cultural practice. In ethnographic studies of computation, this kind of qualitative analysis typically involves identifying social practice with particular sets of complex technical objects such as 'algorithms' or 'data'. These often-unseen yet "material" things attain a sort of cultural salience (i.e., conventionality or symbolism) sometimes independent from how they locally interact with and are dependent on other technical components, human agency or the disciplinary history of the particular computer science concepts in question (Dourish 2013). Indeed, computer scientist and theorist Paul Dourish notes that social scientists investigating such digital technologies might themselves risk fetishizing particular elements within "digital assemblages" (2016), the nature of the connections between these elements (2013), or how they materially come together via human convention (2017, 2014). Such difficulties in separating observational description, expert heuristic and lay understanding of digital technologies consistently plague the attempts to show how

[11] As discussed in Mackenzie (2002, p. 24). See Kitchin (2017) for this argument made particularly for studies of computation.

computational objects and processes do social and cultural work. For ethnographers to identify specific problems and solutions to social problems in, say, apps and algorithms, more work is obviously needed to show how the specific elements of digital assemblages like algorithms, code or data appear in themselves atomistic and context-independent when the context for their reproduction is rather reconstructed from the medium itself (see Kockelman 2017).

However, beyond the theoretical ethnographic concerns about studying the broad social impact of digital technology, even the expert use of these technologies involves coordinating disparate cultural meanings and precise technical reference. Janet Vertesi and Dourish contend that even within technical collaborations amongst researchers in a single disciplinary field, scientific data are frequently subject to processes of commodification and fetishization more typically associated with lay understanding or outside appropriation of technical work (2011). Vertesi and Dourish show how NASA researchers engage in technical "fetishization" in the professional distribution of scientific data such that the social context of data production often determines the way that the scientific data sharing actually takes place. They claim that the "outsides" and "insides" of data practices are actively maintained by researchers constructing informatic systems (see also Bowker & Star 1999, Star & Griesemer 1989). As Cathy O'Neil insightfully argues, even the definitions given to digital infrastructure (and particularly algorithms) needlessly cast important decision-making processes as inherently technical and mathematical. These mathematical definitions go on to determine who can decide what digital infrastructures "decide" on a societal scale (2016). The boundary-making capacity of these technical definitions can be extended from O'Neil's larger questions of public access in governance to consequential micro-scale interactions in collaborations like those Vertesi and Dourish discuss, including, say, medicine and computer science. Although there may be "science

friction" which occurs between data and digital technology shared amongst disciplines (Edwards et al. 2010), we might interpret Vertesi and Dourish's work to suggest that the fetishization of technology can also be considered a meaningful and communicative (if sometimes still sub-optimal) way in which technologies are harnessed and made to work in a particular disciplinary (i.e., cultural) context. Studies of computation and the expansion of digital technology, as well as projects in digital and open medicine, are well positioned to take up O'Neil's sense of the plasticity of these technical definitions and the calls for a pragmatic and accessible language for computation qua decision making.

My own attention to components of Persephone's digital assemblage is intended to correspond to their practical organization in the context of decision-making processes that occurred in the lab. Though technological systems like apps or other software can appear as unyielding systems of mechanical mediation or machinic contiguity, by emphasizing practices of care, ethnography can show how, at the level of research and development, symbolism and conventionality ultimately hold these malleable systems together (see Dourish 2017 and Kockelman 2017). Accordingly, the local understandings of digital technologies as technical objects with well-defined functions in care both determine the relative mediation of technology and come to reflect the later acceptable practices involving material things, like data or diagnoses, generated by the technology. As Martin, Meyers and Viseu have noted, *care* is a deeply semiotic engagement and always already "an affectively charged and selective mode of attention… and in effect, it draws attention away from other things." (2015) The technologies which are made imminent for care draw attention to particular dimensions of mediation and immediacy over others.

I discuss one particular site in which psychiatrists implemented digital infrastructures for use in clinical research with the aim of later being able to deploy it in clinical care. I first show how psychiatry intersects with tech entrepreneurialism while maintaining its own disciplinary boundaries. I address the changes such work poses to market structures and commodification processes involving digital technology. I then explore how the incorporation of digital technologies into psychiatric practices figures more concretely within medical practice and the mediation of neuropathological symptoms. Taken together, my work makes the argument that entrepreneurial frameworks, digital transpositions and even the difficult language of dense machine learning algorithms don't necessitate a systemic violence inherent in the expansion of digital technology itself, but rather that they can be consciously deployed as a means for articulating the promise of reparative infrastructures in direct contrast to these other models. Modes of ethnographic engagement with data, algorithms and platforms can be adopted toward a more open and accountable use. As I describe it, psychiatric science remains a hopeful site for the articulation of reparative approaches to the ubicomp agenda now dominated by high technology corporate interests. Indeed, if Silicon Valley's lofty goals of expansion are beginning to shift from consumer technology to instrumentalizing the even larger markets of new medical infrastructures, then these trust-based understandings of technological mediation could be emerging wide-spread rhetorical discourses. Of course, attention to the disparities between projects developed by research laboratories and projects that have been scaled-up through collaboration with high technology corporations and other financial interests is an important endeavor for future ethnographic engagements in computation and digital health.

WORKS CITED (from full paper)

Agha, Asif. 2011. “Meet Mediatization.” *Language & Communication*, Mediatized Communication in Complex Societies, 31 (3): 163–70. doi:10.1016/j.langcom.2011.03.006.

Agre, Philip E. 1994. “Surveillance and Capture: Two Models of Privacy.” *The Information Society* 10 (2): 101–27. doi:10.1080/01972243.1994.9960162.

American Psychiatric Association. 2013. *Diagnostic and Statistical Manual of Mental Disorders: DSM-5*. 5th ed. Washington, D.C: American Psychiatric Association.

Bakhtin, Mikhail. 1984. *Rabelais and His World*. Bloomington: Indiana Univ. Press.

Beer, David. 2017. “The Social Power of Algorithms.” *Information, Communication & Society* 20 (1): 1–13. doi:10.1080/1369118X.2016.1216147.

Blumtritt, Jeorg. 2015. “Slow Data.” *Beautiful Data*. February 7. http://beautifuldata.net/2015/02/slow-data/.

Bowker, Geoffrey C., and Susan Leigh Star. 2000. *Sorting Things Out: Classification and Its Consequences*. MIT Press.

Briggs, Charles, and Daniel Hallin. 2016. *Making Health Public: How News Coverage Is Remaking Media, Medicine, and Contemporary Life*. Abingdon: Routledge.

Chandra, Anita. 2016. *Building a National Culture of Health: Background, Action Framework, Measures, and next Steps*. Research Report, RR-1199-RWJ. Santa Monica, Calif: Rand Corporation.

Choudhury, Suparna, and Jan Slaby. 2012. “Critical Neuroscience: Between Lifeworld and Laboratory.” *Critical Neuroscience: A Handbook of the Social and Cultural Contexts of Neuroscience*, 1–26.

Chun, Wendy Hui Kyong. 2008. “On ‘Sourcery,’ or Code as Fetish.” *Configurations* 16 (3): 299–324. doi:10.1353/con.0.0064.

———. 2011. *Programmed Visions: Software and Memory*. Software Studies. Cambridge, Mass: MIT Press.

Dorsen, Annie. 2012. “On Algorithmic Theatre.” *Theater Magazine*.

Dourish, Paul. 2013. *Paul Dourish: Closing Panel in Governing Algorithms*. Governing Algorithms. New York: New York University School of Law. https://vimeo.com/channels/551921.

———. 2014. “No SQL: The Shifting Materialities of Database Technology.” *Computational Culture*, no. 4.

———. 2016. “Algorithms and Their Others: Algorithmic Culture in Context.” *Big Data & Society* 3 (2). doi:10.1177/2053951716665128.

———. 2017. *The Stuff of Bits: An Essay on the Materialities of Information*. MIT Press.

Dourish, Paul, and Genevieve Bell. 2011. *Divining a Digital Future: Mess and Mythology in Ubiquitous Computing*. Cambridge, Mass: MIT Press.

Edwards, Paul N., Matthew S. Mayernik, Archer L. Batcheller, Geoffrey C. Bowker, and Christine L. Borgman. 2011. “Science Friction: Data, Metadata, and Collaboration.” *Social Studies of Science* 41 (5): 667–90. doi:10.1177/0306312711413314.

Fernandes, Brisa S., Leanne M. Williams, Johann Steiner, Marion Leboyer, André F. Carvalho, and Michael Berk. 2017. “The New Field of ‘Precision Psychiatry.’” *BMC Medicine* 15 (April): 80. doi:10.1186/s12916-017-0849-x.

Fourcade, Marion, and Kieran Healy. 2017. “Seeing like a Market.” *Socio-Economic Review* 15 (1): 9–29. doi:10.1093/ser/mww033.

Friend, Stephen. 2014. *The Hunt for “Unexpected Genetic Heroes.”* Vancouver, BC: TED. https://www.ted.com/talks/stephen_friend_the_hunt_for_unexpected_genetic_heroes.

Galloway, Alexander R. 2006. *Gaming: Essays on Algorithmic Culture*. Electronic Mediations 18. Minneapolis: University of Minnesota Press.

———. 2012. *The Interface Effect*. Cambridge, UK: Polity Press.

Galloway, Alexander R., and Jason R. LaRivière. 2017. “Compression in Philosophy.” *Boundary 2* 44 (1): 125–47. doi:10.1215/01903659-3725905.

Gillespie, Tarleton, and Nick Seaver. 2015. “Critical Algorithm Studies: A Reading List.” *Social Media Collective*. November 5. https://socialmediacollective.org/reading-lists/critical-algorithm-studies/.

Goffman, Erving. 1959. *The Presentation of Self in Everyday Life*. New York: Anchor Books.

Good, Byron. 1990. “The Narrative Representation of Illness.” In *Medicine, Rationality and Experience: An Anthropological Perspective*. Cambridge, UK: Cambridge University Press.

Insel, Tom. 2017. *Three Revolutions in Mental Health*. Wearable Tech + Digital Health + Neurotech Conference. Stanford University: ApplySci. https://www.youtube.com/watch?v=-na-qT2Ubtw.

Kaplan, Frederic. 2014. “Linguistic Capitalism and Algorithmic Mediation.” *Representations* 127 (1): 57–63.

Kapur, S., A. G. Phillips, and T. R. Insel. 2012. “Why Has It Taken so Long for Biological Psychiatry to Develop Clinical Tests and What to Do about It?” *Molecular Psychiatry* 17 (12): 1174–79. doi:10.1038/mp.2012.105.

Kirkpatrick, Keith. 2017. “It’s Not the Algorithm, It’s the Data.” *Communications of the ACM* 60 (2): 21–23. doi:10.1145/3022181.

Kitchin, Rob. 2017. “Thinking Critically about and Researching Algorithms.” *Information, Communication & Society* 20 (1): 14–29. doi:10.1080/1369118X.2016.1154087.

Knorr Cetina, Karin. 2003. “From Pipes to Scopes: The Flow Architecture of Financial Markets.” *Distinktion: Scandinavian Journal of Social Theory* 4 (2): 7–23.

Kockelman, Paul. 2010. “Enemies, Parasites, and Noise: How to Take Up Residence in a System Without Becoming a Term in It.” *Journal of Linguistic Anthropology* 20 (2): 406–21. doi:10.1111/j.1548-1395.2010.01077.x.

———. 2014. “Linguistic Anthropology in the Age of Language Automata.” In *The Cambridge Handbook of Linguistic Anthropology*, edited by Enfield Nick, Paul Kockelman, and Jack Sidnell. Cambridge, UK: Cambridge University Press.

———. 2016. *The Chicken and the Quetzal*. Durham, US: Duke University Press.

———. 2017. *The Art of Interpretation in the Age of Computation*. Oxford University Press.

Langlitz, Nicolas. 2016. “We might have a brighter future if we stopped conceiving of ourselves as an epistemic counterculture” – An Interview with Nicolas Langlitz Interview by Des Fitzgerald. http://www.histhum.com/?p=20.

Lomborg, Stine, and Kirsten Frandsen. 2016. “Self-Tracking as Communication.” *Information, Communication & Society* 19 (7): 1015–27. doi:10.1080/1369118X.2015.1067710.

Lowrie, Ian. 2016. “On Algorithmic Communism.” *Los Angeles Review of Books*. https://lareviewofbooks.org/article/on-algorithmic-communism/.

Luhrmann, T. M. 2001. *Of Two Minds: An Anthropologist Looks at American Psychiatry*. New York: Vintage Books.

Lupton, Deborah. 2012. “M-Health and Health Promotion: The Digital Cyborg and Surveillance Society.” *Social Theory & Health* 10 (3): 229–44. doi:10.1057/sth.2012.6.

———. 2014. “Apps as Artefacts: Towards a Critical Perspective on Mobile Health and Medical Apps.” *Societies* 4 (4): 606–22. doi:10.3390/soc4040606.

———. 2016. *The Quantified Self*. Cambridge, UK: Polity Press.

Lyon, David. 2015. *Surveillance after Snowden*. Cambridge, UK: Polity Press.

Mackenzie, Adrian. 2002. *Transductions: Bodies and Machines at Speed*. London; New York: Continuum.

Mann, Steve, Jason Nolan, and Barry Wellman. 2002. “Sousveillance: Inventing and Using Wearable Computing Devices for Data Collection in Surveillance Environments.” *Surveillance & Society* 1 (3): 331–355.

Martin, Aryn, Natasha Myers, and Ana Viseu. 2015. “The Politics of Care in Technoscience.” *Social Studies of Science* 45 (5): 625–641.

Martin, Paul. 2015. “Commercialising Neurofutures: Promissory Economies, Value Creation and the Making of a New Industry.” *BioSocieties* 10 (4): 422–43. doi:10.1057/biosoc.2014.40.

Mcintosh, Janet. 2010. “Mobile Phones and Mipoho’s Prophecy: The Powers and Dangers of Flying Language.” *American Ethnologist* 37 (2): 337–53. doi:10.1111/j.1548-1425.2010.01259.x.

Mody, Cyrus. 2015. “What Kind of Thing Is Moore’s Law?” *IEEE Spectrum: Technology, Engineering, and Science News.* April 6. http://spectrum.ieee.org/semiconductors/devices/what-kind-of-thing-is-moores-law.

Montgomery, Kathryn. 2006. *How Doctors Think: Clinical Judgment and the Practice of Medicine*. Oxford: Oxford University Press.

Neyland, Daniel, and Norma Möllers. 2017. “Algorithmic IF … THEN Rules and the Conditions and Consequences of Power.” *Information, Communication & Society* 20 (1): 45–62. doi:10.1080/1369118X.2016.1156141.

O’Neil, Cathy. 2016. *Weapons of Math Destruction: How Big Data Increases Inequality and Threatens Democracy*. First edition. New York: Crown.

Onnela, Jukka-Pekka, and Scott L. Rauch. 2016. “Harnessing Smartphone-Based Digital Phenotyping to Enhance Behavioral and Mental Health.” *Neuropsychopharmacology* 41 (7): 1691–96. doi:10.1038/npp.2016.7.

Orr, Jackie. 2009. “Biopsychiatry and the Informatics of Diagnosis.” In *Biomedicalization : Technoscience, Health, and Illness in the U.S.*, edited by Adele E. Clark, Laura Mamo, Jennifer Ruth Fosket, Jennifer R. Fishman, and Janet K. Shim. Durham, US: Duke University Press Books.

Pasquale, Frank. 2015. *The Black Box Society: The Secret Algorithms That Control Money and Information*. Cambridge, Mass: Harvard University Press.

———. 2016. “Two Narratives of Platform Capitalism.” *Yale L. & Pol’y Rev.* 35: 309.

Pype, Katrien. 2016. "'[Not] Talking like a Motorola': Mobile Phone Practices and Politics of Masking and Unmasking in Postcolonial Kinshasa." *Journal of the Royal Anthropological Institute* 22 (3): 633–652.
Rapp, Rayna. 1998. "Refusing Prenatal Diagnosis: The Meanings of Bioscience in a Multicultural World." *Science, Technology & Human Values* 23 (1): 45–70.
Schüll, Natasha Dow. 2016. "Data for Life: Wearable Technology and the Design of Self-Care." *BioSocieties* 11 (3): 317–33.
Serres, Michel. 1982. *The Parasite*. Translated by Lawrence R. Schehr. Baltimore: Johns Hopkins University Press.
Srnicek, Nick. 2017. *Platform Capitalism*. Cambridge, UK: Polity Press.
Star, Susan Leigh, and James R. Griesemer. 1989. "Institutional Ecology, 'Translations' and Boundary Objects: Amateurs and Professionals in Berkeley's Museum of Vertebrate Zoology, 1907-39." *Social Studies of Science* 19 (3): 387–420.
Steinberg, David, Geoffrey Horwitz, and Daphne Zohar. 2015. "Building a Business Model in Digital Medicine." *Nature Biotechnology* 33 (9): 910–20. doi:10.1038/nbt.3339.
Swaminathan, Usha, and Remola Premalatha. 2016. "Financing Intellectual Property Assests: An Empirical Analysis." *The Journal of Internet Banking and Commerce*, September. peer-reviewed/financing-intellectual-property-assests-an-empirical-analysis-79692.html.
Torous, J, J-P Onnela, and M Keshavan. 2017. "New Dimensions and New Tools to Realize the Potential of RDoC: Digital Phenotyping via Smartphones and Connected Devices." *Translational Psychiatry* 7 (3): e1053. doi:10.1038/tp.2017.25.
Torous, John. 2016. "Digital Psychiatry: The Year Ahead." *Psychiatric Times*, February 4. http://www.psychiatrictimes.com/telepsychiatry/digital-psychiatry-year-ahead.
Torous, John B., Steven R. Chan, Peter M. Yellowlees, and Robert Boland. 2016. "To Use or Not? Evaluating ASPECTS of Smartphone Apps and Mobile Technology for Clinical Care in Psychiatry." *The Journal of Clinical Psychiatry* 77 (6): 734–38. doi:10.4088/JCP.15com10619.
Torous, John, and Laura Weiss Roberts. 2017. "Needed Innovation in Digital Health and Smartphone Applications for Mental Health: Transparency and Trust." *JAMA Psychiatry* 74 (5): 437–38. doi:10.1001/jamapsychiatry.2017.0262.
Torous, John, Patrick Staples, and Jukka-Pekka Onnela. 2015. "Realizing the Potential of Mobile Mental Health: New Methods for New Data in Psychiatry." *Current Psychiatry Reports* 17 (8): 602. doi:10.1007/s11920-015-0602-0.
United States Food and Drug Administration. 2017. "Mobile Medical Applications: Guidance for Industry and Food and Drug Administration Staff." Accessed February 21. https://www.fda.gov/downloads/MedicalDevices/.../UCM263366.pdf.
Van Dijck, José. 2014. "Datafication, Dataism and Dataveillance: Big Data between Scientific Paradigm and Ideology." *Surveillance & Society* 12 (2): 197.
Vertesi, Janet, and Paul Dourish. 2011. "The Value of Data: Considering the Context of Production in Data Economies." In *Proceedings of the ACM 2011 Conference on Computer Supported Cooperative Work*, 533–542. ACM. http://dl.acm.org/citation.cfm?id=1958906.
Ziewitz, M. 2016. "Governing Algorithms: Myth, Mess, and Methods." *Science, Technology & Human Values* 41 (1): 3–16. doi:10.1177/0162243915608948.
Zuboff, Shoshana. 2015. "Big Other: Surveillance Capitalism and the Prospects of an Information Civilization." *Journal of Information Technology* 30 (1): 75–89. doi:10.1057/jit.2015.5.