Should a medical digital twin be viewed as an extension of the patient's body?

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The concept of a digital twin comes from engineering.[1] It refers to a digital model of an artefact in the real world, which takes data about the artefact itself, data about other such artefacts, among other things, as inputs. The idea is that the maintenance of artefacts—such as jet engines—can be vastly improved if we work with digital twins that simulate actual objects. Similarly, personalised medicine might benefit from the digital modelling of body parts or even whole human bodies. A medical digital twin could use data about the patient, more general population data, and other inputs to generate predictions about the patient. This could lead to highly personalised interventions and nuanced judgments about the patient's health. Matthias Braun[2] discusses this intriguing prospect, asking how we should think about the way(s) in which a digital twin could represent a patient. I will respond to Braun's striking suggestion that we can regard a digital twin as an extension of the patient's body.

Notably, Braun does not compare his just-mentioned idea with the extended mind thesis popularised by Andy Clark and David Chalmers.[3] But I am sure many readers will be reminded of the extended mind thesis. Accordingly, I will consider this comparison. I cannot discuss this comparison in detail, nor fully evaluate Braun's suggestion. But I can say something about how we might approach this comparison, and provide some tools we could use to assess Braun's claim that it makes sense to view digital twins as an extension of patients' bodies.

When Braun discusses the idea of digital twins as an extension of patients' bodies, he likens a digital twin with a prosthesis. A first reaction one might have to this is that there is a crucial difference here: a digital twin is a simulated model, generated in a computer, whereas a prosthesis is a physical entity attached directly to a patient's body, for example, the prosthetic leg of a patient who has lost a leg. Something must be physical and attached to a person's body, it might be thought, for it to make sense to view it as an extension of the person's body. If a digital twin can exist far away from the patient, and is not a physical entity, it might not make sense to view this digital twin as an extension of the patient's body.

However, if we focus on the intended function of a digital twin—and more generally take up a functionalist perspective when we think about people and their capacities—it might make more sense to think that there is a way in which a digital representation could be viewed as an extension of a patient's body. That is, if we think that a digital twin could perform functions the patient's physical body would otherwise perform, the idea of viewing the digital twin as an extension of the patient's body becomes less peculiar. For example, instead of testing whether some medical treatment is safe and effective by trying it out on the patient, the tests might be simulated on the digital twin first. If the simulation indicates that the treatment is safe and effective, it can be administered in the real world on the patient themselves.

This functional perspective is at the heart of the extended mind thesis.[3] Clark and Chalmers suggest that when couplings of human agents and entities like computers or even low-tech artefacts like pen and paper form functional systems that perform functions associated with human minds, extended minds are created. The mind of the human agent is extended out into the technology (or broader environment) that enables the human-technology composite to perform the relevant functions.

We can test Braun's suggestion that we should view medical digital twins as an extension of patients' bodies by applying the tests Clark and Chalmers (3: 8–9, 17) use to determine whether something outside of a person's body can be thought to be part of their mind. On one hand, Clark and Chalmers suggest that the following three conditions should hold for it to make sense to see a human and a piece of technology as a 'coupled cognitive system': (1) all system components should play active causal roles, whereby elements inside and outside of the person's body affect each other; (2) all system components help to regulate the behaviour of the agent in the way a mind is usually thought to do; and (3) if the external parts (eg, a computer or the pen and paper) are removed, the overall system's behavioural capacities are diminished. On the other hand, not all external parts of the environment or technologies we use are part of extended minds, as Clark and Chalmers see things. The following three conditions should hold: (1) the external component is a constant, reliable part of the person's life; (2) the information or other inputs from the external part(s) should be easily available; and (3) the person needs to be disposed to automatically endorse the inputs from the external parts.

Yet another test Clark and Chalmers (3: 18) suggest for whether something is part of a person's 'extended mind' is moral in nature: would it be an assault on a person or their mind if we remove, destroy, or otherwise interfere with the external part? If so, it makes sense to view the external entity as part of the person's extended mind.

My suggestion is that when we reflect on whether to view a digital twin as an extension of a person's body, we can think in the terms that Clark and Chalmers do when they approach the issue of whether something is part of an extended mind. For example, we can use the moral test: would it be an assault on the patient or their body to remove, destroy, or otherwise interfere with their digital twin?

We can also use the more 'theoretical' tests described above: is there a causal connection between the patient's body and the digital twin? Do the digital twin and the person's body jointly regulate the patient's behaviour? Would the removal of the digital twin mean a significant drop in the patient's capacities? Moreover, is the digital twin a reliably available resource? Is the information provided by the digital twin readily available to the patient? Does the patient habitually endorse the inputs from the digital twin?

If the answers to these questions are all yes, the tests Clark and Chalmers describe in relation to extended minds could be said to support Braun's suggestion that a digital twin can be regarded as an extension of a patient's body. If the answers to such questions are mostly no, or asking these questions does not make

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sense in relation to digital twins, then the suggestion to view digital twins as an extension of patients' bodies loses its plausibility.

Contributors I am the sole author.

Funding This study was funded by NWO (024.004.031).

Competing interests None declared.

Patient consent for publication Not required.

Provenance and peer review Commissioned; internally peer reviewed.

To cite Nyholm S. *J Med Ethics* 2021;**47**:401–402.

Received 1 April 2021
Accepted 9 April 2021
Published Online First 7 May 2021

► http://dx.doi.org/10.1136/medethics-2020-106134

J Med Ethics 2021;**47**:401–402.
doi:10.1136/medethics-2021-107448

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