

## **Dr Goff, Tear Down This Wall! The Interface Theory of Perception and the Science of Consciousness**

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### **Abstract**

In his book “Galileo’s Error”, Philip Goff lays out what he calls “foundations for a new science of consciousness”, which are decidedly anti-physicalist (panpsychist), motivated by a critique of Galileo’s distinction into knowable objective and unknowable subjective properties and Arthur Eddington’s argument for the limitation of purely structural (physical) knowledge.

Here we outline an alternative theory, premised on the Interface Theory of Perception, that too subscribes to a “post-Galilean” research programme. However, interface theorists disagree along several lines. 1. They note that Galileo’s distinction should be replaced by a truly non-dual account, referring to a difference of degree only. 2. They highly appreciate the role of mathematics, in particular when it comes to actually engaging scientifically with consciousness.

Some notable features of the interface theory are its skepticism towards our epistemic capacities and its rejection of the existence of a public, mind-independent reality. In addition, some interface theorists further employ a thin concept of “conscious agency” to ground their theory.

The interface theory leaves open many of the problems of consciousness science (e.g. what is a “self”?) as questions for further (scientific, mathematical) research.

## Introduction<sup>1</sup>

Being a non-dualist is hard. Really hard. On the surface, it appears that simply rejecting the distinction into the categories of “mind” and “matter” suffices for being a non-dualist. But this is not the whole story. Most often, what happens is that dualisms of some sort are smuggled into one’s theory through the backdoor. Daniel Dennett famously declared people who reformulated Cartesian assumptions within a materialistic theory (e.g. that “consciousness” is to be found in a single unified center of physical processing) to be “Cartesian materialists” (Dennett 1991). Philip Goff, on the other hand, calls for a “post-Galilean science of consciousness” that rests on the assumptions of “realism about consciousness”, “empiricism”, and “non-dualism” (p. 174)<sup>2</sup>. We applaud Goff for this bold declaration.

Yet, the devil is in the details. For example, his clear-cut distinction into categorical (“intrinsic”) and dispositional (“structural”) might seem to be just a “dualism in disguise”.<sup>3</sup> A lot of this is motivated by an “error” made by Galileo Galilei who distinguished between the mathematically describable properties of public physical objects and the subjective properties of consciousness. This might seem as an act of ignorance on the part of Galileo. However, one of the main reasons that science has been so successful is precisely because it excluded conscious experience right from the start.

But what to do if the goal is now to construct a science of consciousness? We appreciate the point made by Arthur Eddington and others that physical knowledge is ultimately only about the relation of pointer readings. This kind of knowledge is incomplete and leaves out any knowledge about the intrinsic nature of things. Goff’s suggestion: “Plug the hole with consciousness” (p. 132).

However, if one wants to stick to a truly non-dual solution, then adopting something similar to the following might be helpful (if not necessary). We would like to regard both types of statements, the ones about public

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<sup>2</sup> When not otherwise indicated, page numbers pertain to (Goff 2019). We also use “panpsychism” to refer to the specific position that is (we believe) held by Goff. It has been pointed out (e.g. by Skrbina 2005) that panpsychism should be understood more broadly, in terms of a framework that encompass a variety of views that all agree on mind being ubiquitous and fundamental. Given this more liberal reading, the view presented here qualifies as an instance of a “pro-panpsychism”.

<sup>3</sup> Though to be fair, Goff’s self-understanding is explicitly non-dual (p. 135f.). But when he says that “physical properties *are themselves* forms of consciousness” [emphasis PG] isn’t this rather “idealism in disguise”?

physical<sup>4</sup> objects and the ones about the subjective properties of consciousness to differ by degree and not category. Another, related, issue pertains to the role of mathematics for the science of consciousness – and we explicitly encourage the use of mathematics to study consciousness, rather than pointing to its limitations. True enough, mathematical knowledge might be incomplete in the sense that it only ever captures mere structure. However, we claim that it is precisely mathematics that lets us understand how some (apparently) “objective” structures could have emerged in the first place.<sup>5</sup>

### **The Interface Theory of Perception**

The account discussed here is premised on the idea that we have limited insight into the “true nature of reality”, eventually tearing down the categorical wall that separates “mind” from “matter”. We believe that some of the crucial questions that we encounter along the way could be answered with the help of mathematical concepts such as “structure preserving maps”, “information geometry”, or “higher categories”. It is out of the scope of this brief discussion to work out an answer to any of these questions. Still, we hope to invoke a sense of urgency to deal with them but also the conviction that this can be done in principle.

One defining property of consciousness expresses an epistemic limitation: facts about consciousness are accessible (at least in part) only from what is called a “first-person perspective” (Chalmers 2004). No amount of scientific, objective knowledge seems to make it intelligible why experience appears to have certain properties (e.g. qualia) that we attribute to them based on this first-person perspective. Goff (p. 69ff) makes us aware of this when discussing Frank Jackson’s knowledge argument (Jackson 1982, 1986). Whether or not one agrees with any ontological conclusion drawn from this, it poses some interesting epistemic challenges.

The first-person-perspective has been subject to a lot of controversy, with some people shedding doubt on the coherence of the very concept of unmediated forms of knowledge (or “givens”) derivable from it (e.g. Sellars 1963, Dennett 1991, Metzinger 2003, Prentner 2019). Recently, there has been much interest in the question how a creature (or: its brain) comes up with a model of itself (Metzinger 2003). Some people have

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<sup>4</sup> Note that we intend “physical” to mean: void of any form of consciousness, “fully external” so to say (Prentner 2018). There exist different uses of the word “physical” (cf. Strawson 2006, Stoljar 2017) about which we do not speak here.

<sup>5</sup> Without having a firm, mathematical handle on what “structure” is supposed to mean, the questions of its emergence are meaningless. The idea is that “objective” properties arise as “transformation invariants” of experiential processes; for related ideas see Robert Nozick’s (2001) Invariances, Alfred N. Whitehead’s “method of extensive abstraction” (Whitehead 2015), or the “objective idealisms” discussed in (Atmanspacher 2020).

even speculated that this could explain how consciousness is nothing but the brain’s self-attribution of a private inner-life (Graziano & Kastner 2011, Frankish 2017). By contrast, less attention has been directed to the complementary question of how a creature comes up with a model of its world, thereby attributing a public, physical existence to it. The catch is that such a model would not need to resemble the “objective” state of the world. It would not even need to explicitly encode a *specific* worldly state.<sup>6</sup> Basic evolutionary thinking merely tells us that all a creature must do is to act successfully in its world, and its internal (cognitive) architecture must be such that this is possible (Mark et al. 2010, Hoffman et al. 2015a, Guez et al. 2019, Prakash et al. 2020, in press) – metaphorically speaking: it needs to have an interface that lets it deal with its world. Truthful representation takes the backseat.

We are nothing but such creatures. There are two consequences of this if one is willing to think it through radically. First, it extends to empirical knowledge as such, *dispensing with the availability of a physical “ground truth”*: space-time is the species-specific data format of our interface (Hoffman et al. 2015a), objects are error-corrected representations of fitness consequences (Fields et al. 2017), and even quantum mechanics ultimately plays out on this interface (Prakash 2019). Second, there is *no in-principle distinction between “public” and “private”* forms of knowledge, since both refer to procedures relative to our interface.

What is left might be a mere collection of processes that relate perceptions to actions. This additional claim seems quite natural, since it is premised on the assumption that we all have experience and (try to) do something about it – arguably, nothing could be more basic than that. Since this basic assumption has an active connotation where perceptions have (often unintended) consequences, one might refer to these processes as “agents”<sup>7</sup> (Hoffman & Prakash 2014, Fields et al. 2017). The main task is then to show how one could recover the appearance of a public, physical world (inhabited by non-physical selves) from interactions between such agents.<sup>8</sup>

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<sup>6</sup> It turns out that experiences need not be in a one-to-one correspondence to (assumed) physical states but could correspond to probabilistic combinations thereof; cf. the example in (Prakash et al. in press).

<sup>7</sup> Note that this usage of the word “agent” refers to a very thin notion, unlike a stronger notion of “agency” that carries, say, connotations of embodiment or environmental embedding (Prentner & Fields 2019), or spatio-temporal realization.

<sup>8</sup> Note that this is not *subjective* idealism, if one believes in the objective reality of these processes; also note that the idea is not a variant of sense datum theory, even though it might appear as such when interface theorists speak of “perceptual icons”. There are only (perceptual) experiences, and not “experience-objects” that we are aware of (Hoffman et al. 2015b).

## What is ‘really real’?

Imagine you are immersed in a virtual reality version of Grand Theft Auto (GTA). You are interacting with computer-generated content such as steering wheels, cars, policemen, and pedestrians. There is an “external reality”, namely the computer that governs the objects that you see, but its description does not involve steering wheels, cars, policemen, or pedestrians. Trying to understand the behaviour of the computer (its program) using these categories would be foolish. Lines of computer code do not resemble steering wheels. You cannot even rely on causality. Intervening with the steering wheel might have the observable consequence of driving into a wall (all other things being equal), but steering wheels do not cause crashes in GTA, the program does. Perhaps you still think that using steering wheels and other types of interventions lets you figure out what program the computer is running. Good luck.

Moreover, GTA employs algorithms (a so-called “physics-engine”) that simulate the realistic behaviour of objects, even those you do not interact with. For example, objects that land in water will create ripples and wave patterns in response. Whether you are successful at the game has nothing to do with your grasp of the nature of these underlying mechanisms but only with your ability to manipulate virtual contents in a way that lets you score points.

Is simulated physics unreal? What is “really real”? And how could we find out? Rather than pondering the true nature of this external reality (Is it physical? Is it a mere simulation by a highly-evolved alien species? Has it something to do with consciousness?), it might initially be a better strategy to ask about the principles and mechanisms underlying its appearance as being *stable* (steering wheels generally do not turn into gear shifters), *consistent* (killing pedestrians leads to being chased by policemen), and *law-like* (objects that fall into water create ripples) – properties we typically attribute to the world around us. Philosophically speaking, we have shifted from a transcendent question about the nature of reality to a transcendental one about the conditions of possibility of its experience (Kant 1998).

Of course, computer games and virtual reality simulations are not the real world, and the metaphor above breaks down eventually. In the following, we therefore wish to translate the question about its appearance into the language of the interface theory of perception. This will intentionally be done non-mathematically.<sup>9</sup>

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<sup>9</sup> The interested reader is referred to (Hoffman et al. 2015a) for mathematical details.

The interface theory assumes a mapping  $P$  from an external world (the computer running the program) to the contents of our perceptions that comprise steering wheels and pedestrians. Likewise, when we see pedestrians, we can decide to turn the steering wheel to the left to avoid hitting them. Abstractly, this could be represented by a mapping  $D$  that connects perceptions to actions. Finally, certain actions affect ( $A$ ) the external world of the computer and feed back into our perceptions at some later time ( $P'$ ). For example, we might see that the steering wheel indeed moved to the left and we consequently avoided hitting the pedestrian. Note here that we are never in perfect control of the situation. While we can choose actions, those actions might or might not be successful. This is life, unfortunately. We also, strictly speaking, do not perceive these actions, but only their consequences at future times. Seeing the steering wheel turning left is a consequence of a (successful) action, it does not token the action as such. We *initially did not intend* to do a left turn, but we *learned* to execute actions that typically result in perceptions as of left turns. These are some of the basic ingredients of the theory – in a nutshell: an agent’s perception is the representation of its external world, based on the consequences of past actions. A “decision-process” mediates between perceptions and actions and could incorporate, in more sophisticated settings, things like memory, goals, or predictions.

An interesting question is now: What properties do these structures need to have in order to guarantee future perceptions to appear as if they were consistent with a representation of an objective world? Possible answers would specify the types of mappings and representations that make good interfaces. They would be specifications about mathematical entities, for example:

- **Stability.** The mapping from this world to our experience is relatively stable, although the mapping need not be structure-preserving in any substantial sense.<sup>10</sup> Otherwise we were not able to do anything useful. In particular, a system would not be able to decide on any given course of action (if steering wheels might suddenly turn into gear shifters, then there is no point in deciding to turn the wheel to the left, cf. Durham (2020)).
- **Consistency.** This is about action-consequences, and how they feed back into future perceptions. Future perceptions should be consistent with the actions an agent previously took (modulo the uncertainty whether they succeeded or not). But not all our actions have an effect, and not all effects we perceive are due to our actions. Thus, we also need to ensure:

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<sup>10</sup> Of course, gradual changes (e.g. over “phylogenetic” periods of time) are possible.

- **Law-like behavior.** Things that cannot be subjectively influenced should enter in a “nice” (predictable) way into our experience. This does not mean that just because we could predict something, there exists some objective (i.e. agent-independent) law that governs its behavior. There can be “laws without laws”, based on predictability (Müller 2020).

More refined models will likely capture some structural aspects of our perceptual interface, and will extend them using symmetry considerations (e.g. we perceive space as locally Euclidean; using translation invariance, we end up with a Euclidean model of space).

### **How do agents agree?**

So far, the discussion mainly centred around the appearance of regularities (stability, consistency, law-likeness), discussed against the background of a single agent that perceives, decides, and acts.

An entirely different question pertains to the coordination of the actions of a collection of agents. If we go back to the GTA metaphor, we now look at multiplayer games. (This is unlike the situation where, say, policemen resembled mere icons on our interfaces.) What makes coordination possible? Answering this question by postulating public physical objects, while intuitive, is explanatorily lazy. This would not answer the question, for example, in terms of a mechanism that guarantees (perhaps surprisingly) inter-agent agreement. Instead it would refer to an underlying agent-independent reality that is somehow mirrored in the agents’ experiences and serves as a common point of reference.

A motivating example is given by synesthesia. Synesthetes can have vastly different experiences compared to “normal” people when encountering the same stimuli. For example, whereas I hear a middle C, a synesthete might see, in addition, the colour blue. In the language of the interface theory, the mapping from the external world goes to very different perceptions.

An interesting question is: How different can such mappings be and still allow meaningful interaction between agents? Does this, for example, require a homomorphism between their two interfaces? Can we articulate a more refined or weaker constraint in information-theoretic terms (e.g. based on mutual information)? Could we use the category-theoretical tool of a 2-morphism, that is, a morphism that exists between morphisms (e.g. Dobson & Prentner 2021), letting go of the assumption that there is a single same world underlying the agents’ experience?

Finally, we would not only want to compare the experiences of two (or more) interacting agents, but also ask about the status of the universe that the two observers inhabit. One famous argument in the philosophy of science proceeds via scrutinizing our knowledge (Putnam 1975). In particular, it suggests that the success of science is best explained by the idea that scientific knowledge in fact mirrors (to some extent) an agent-independent reality (Sokal & Bricmont 1998, p.57):

*The main reason for believing scientific theories (at least the best-verified ones) is that [...] it would be a miracle if science said nothing true – or at least approximately true – about the world. The experimental confirmations of the best-established scientific theories, taken together, are evidence that we really have acquired an objective (albeit approximate and incomplete) knowledge of the natural world.*

A possible counter to this argument for “scientific realism” revolves around the notion of “success” and its relativity (Feyerabend 1975). Another counter would grant science its success but rejects the claim that one therefore needs to accept that our theories somehow depict an agent-independent world – or at least that this would be the best explanation for science’s success. Again, the assumption of unguarded (naive) realism strikes us as explanatorily lazy.

Of course, the philosophical literature on this is huge, and we have to limit ourselves to emphasizing certain key points. Typically, our best scientific theories are being evaluated against the results of measurements that single out the “best-verified ones” (using the terminology from above). As such, the most pressing questions will pertain to measurements and how measurements between different agents are related to each other. As a caveat, note that one might wish to limit oneself to the situation where some (perhaps evolutionary formulated) criteria of success are assumed,<sup>11</sup> rather than spelling out an account of what amounts to “acting successfully” – one simply stipulates that there are success criteria and that agents get feedback on whether or not they are met. Any successful interaction between agents would be reinforced, so as to produce stable, seemingly objective structures. While it is highly unlikely, following the interface theory, that such structures would correspond to anything “out there”, a certain subset could give the appearance of a stable backdrop for successful “measurements” (i.e. repeatable, quantifiable, comparable, and consistent interactions).

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<sup>11</sup> This renders this stance somewhat close to pragmatism, taking the notion of a “successful interaction” as primitive.



This raises many open and potentially fruitful questions for the science of consciousness: How do agents decide they are both looking “at the same thing”? How do they agree on any particular “measurement unit” like a yard-stick? What makes the measurements replicable when conducted by different observers at different times? On the face of it, this suggests that “the thing being measured” is the same for all observers, and that “the measurement unit” and “the measurement procedure” are the same for all observers at all times. But is this really the case? How can it be justified? Yet it seems that the concepts involved can be meaningfully translated into mathematical language. For example, replicability might be taken as the possibility to observe a repeatedly occurring event, defined within the context of a stable measurable space.<sup>12</sup>

## **Consciousness**

We have speculated on necessary structural properties of procedures, understood as a sequence of perceptions and actions, relative to interfaces, which could give rise to regularities within and between agents – regularities that might ground measurements and perhaps even the appearance of an agent-independent, public world. However, we have said nothing about “qualia” or “what-it-is-like” to be such an agent. Since these properties take a central role in Goff’s metaphysics, we would like to finally address them.

For example, it has been proposed that the basic ingredients of the universe are “conscious agents”, for which going through sequences of perception and action comes with a distinct raw feeling – it is something like to be such an agent (Hoffman & Prakash 2014, Fields et al. 2018). Yet, one might wish to exactly state what properties typically attributed to consciousness could be recovered from such a description (Kleiner 2020). If one is convinced that any property of consciousness (save a basic “what-it-is-likeness” which is stipulated to begin with) could be recovered from a dynamical system of such agents, this gives rise to the following recipe:

1. Identify the particular property and formalize it
2. Show how it could be recovered from the dynamics (of a network) of such agents.

That such a reconstruction is indeed possible has been conjectured in the form of a “conscious agent thesis” (Hoffman & Prakash 2014). It is the truth of this conjecture that turns the minimal concept of a “conscious agent” into a full-blown description of (typically human) consciousness. This leaves open many questions as to what those properties are (e.g. “selfhood”), what the explananda precisely look like (e.g. how

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<sup>12</sup> In interface language: experience exhibits the same partition over time, and the same subset of experience is “lighting” up repeatedly.

“selfhood” could be formalized), and what their explanations would be (e.g. relatively stable configurations of entangled agents that share a common history). We do not see how progress on such problems could be made without mathematics.

Finally, connecting back to the original distinction of Galileo, let us briefly sketch some alternative positions:

1) Subjective and objective properties are somehow completely different. This is the option that Galileo preferred, but seemingly also Goff when he distinguishes categorically between “intrinsic natures” and structural properties. Both Galileo’s materialism and Goff’s panpsychism seem to presuppose a shared, objective world. 2) There is only individual subjective experience and no shared world at all. This is the position that is traditionally associated with solipsism. 3) A position that would sit somewhere in between, where there are only the distinct interfaces of individual agents as well as something that is shared. This something is arbitrarily different from what is displayed on any of the interfaces, but it would not exist in the absence of agents.

Why should one adopt the latter position? First, it is explicitly non-dual. Whether or not this is really warranted, panpsychists often receive backlash from people who see in panpsychism a way of “injecting” phenomenal properties into physical objects that leads to statements about conscious tables and chairs. Interface theorists arguably do not fall prey to this charge. There is no question of whether matter is “intrinsically” conscious, since material objects are icons on interfaces. An icon is not conscious, and it does not exist in the absence of agents. Second, and more importantly, it stays close to the conventional scientific (mathematical) method: identify a theoretical primitive, give a mathematical description of it (to the extent possible), and derive stuff from there.<sup>13</sup> One of the largest open problems for panpsychism is to explain not just “*any old conscious experience*” but “*our* conscious experience” (Goff 2009). The interface theory promises to tackle this problem.<sup>14</sup>

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<sup>13</sup> There is a trade-off. Whereas panpsychism might be thought to be closer to the (established) scientific worldview, e.g. the standard model with its bottom-up ontology, the interface theory might be thought to align more closely with science’s method of mathematization and the resolution of apparent conflicts (say, between mind and matter) by postulating a more fundamental level of description.

<sup>14</sup> Relatedly, it has been argued that the combination problem does not in fact exist when the interface theory is applied not just to the environment, but also to the observing agent (cf. Fields, this volume).

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