Measurement and mind

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Contents

Abstract

We begin exploring the historical context for the development of measurement, an investigative procedure that has a unique capacity for articulating specific structural descriptions about reality. After exploring the defining features of measurement, including the types of measurement scale that might be used to represent properties, we arrive at an appropriately inclusive definition for measurement that emphasises its specific capacity for description. Following this broad definition, we consider issues regarding the character of measurement, issues that concern theory-dependence and the question of realism, arriving at a defensible stance of realism in the form of Alistair Isaac's "Fixed Point Realism", a stance that successfully accounts for a persisting realism about measurements despite changing theoretical contexts. After defending this form of realism about measurement, we then consider the measurability of mental properties, and the difficulties present when attempting to measure the contents of subjective experience. We explore ideas found within psychophysics, and discuss the dependence on physical proxies when attempting to measure mental properties. Successes regarding measurement of particular sensory modalities are explored with examples including colour experience. We discuss the difficulties with conceiving of pleasure as a measurable mental property, an area riddled with difficulties despite the apparent structural appearance of our experiences of pleasure. Finally, we consider several stances of the mind-body problem to find a suitable context within which to understand the world of measurable physical properties and experienced mental properties. After exploring difficulties relating to emergence of consciousness, we identify the shortfalling of Physicalism and Panpsychism, before arriving at a stance inspired by Jerome J. Valberg's "Horizonal" conception of reality, incorporating ideas presented by James Tartaglia about transcendence to arrive at an understanding for the inexplicability presented in the world knowable to us as measurable properties appearing to us inside subjective experience.

On Measurement and Mind

"No scale used by mortals is perfectly free of their taint" - S. S. Stevens

Section 1: Introduction

Defined in the broadest sense, an instance of measurement is a procedure that articulates useful information about properties, magnitudes or objects in the world in a way that we deem to be objective. The information that measurements offer to us are generally considered to have a certain accuracy and privileged status of trustworthiness that other less objectively verifiable assertions are denied. For instance, you or I might differ on the opinion as to whether or not the teeth of the creature sitting across the room from are large or small, or whether or not its fur is a dark grey or a dark blue colour. Through measurements and the defined frameworks they operate within, we are able to bring to light certain facts which cannot so easily be disagreed upon: if we were to use a meterstick to bravely measure the size dimensions of the creature's teeth, the numerical information offered would not be topic for debate provided we both had faith in this measurement procedure's ability to characterise size in this manner. Similarly, during the heat of our argument regarding the creature's colour we might decide to use a spectrophotometer to analyse the wavelengths of light reflected off the creature's fur, referring to what colour the measured wavelength of light is considered to correlate with. These humble examples of measurement don't immediately make obvious the philosophical significance of measurement in general: articulating information about the world in such ways strips away the veil of subjective appearance and seems to reveal a world of objective facts, (*Tallis 2018: 120-3)*. Through scientific inquiry and the knowledge that the world we are part of can be strictly defined and categorised, we have been able to construct an enormous picture of objective reality and the laws it operates under, much of which we have made accessible to measurement.

Historically, philosophy of measurement has had a deep relationship with both the sciences and mathematics, and understandably so: through our scientific interrogation of the natural world, we have uncovered a certain regularity to how reality operates when understood in a physical sense, a regularity that can often be extremely well articulated through the language of mathematics. It is not surprising then that measurement as an enterprise is often defined as being inherently mathematical, with some theorists on the extreme end of the scale treating the realm of what can be measured as a realm of what can be defined as strictly quantifiable, while others would argue that this is a needlessly dogmatic restriction *(Mari, Maul et al. 2017: 115).* Measured properties that mirror extensive mathematical relations are exceptional in ways that we will explore, however sufficient justification must be given to deny the vast range of properties that aren't strictly quantifiable (temperature to give an uncontroversial example) the privilege of being considered valid objects of measurement.

In the introductory chapter of this thesis we will be considering some historical perspectives on the philosophy of measurement, extracting the broad interdisciplinary working definition of measurement we initially raised from its deep relationship with the physical sciences and mathematics. We will be assuming a realist stance on measurement for sake of discussion in this chapter, which to put simply is to say that we am regarding measurement as a procedure that attempts to characterise a property/magnitude that actually exists in reality independent from the measurement procedure in question; other stances, most notably Operationalism and Conventionalism, sometimes seek to define measurements strictly as products of a measurement procedure one way or another rather than necessarily having a causal relation to the property being measured (*Trout 2000: 270-3)*. We can consider that a small metaphysical leap of faith is required to state that when I weigh my 5kg prize-winning squash that the number on the scale is actually representative of a property that exists beyond my experience of reading a number on the weighing scale. We will be considering the various attempts theorists have made at defining the character of measurement when faced with its apparent dependence on theory and see to what extent we can adopt a perspective of realism towards measurement in Chapter 2, though discussion on the debate will be shelved until then. In the chapters proceeding, we will be considering the capacity measurement has to measure the phenomenal contents of experience, the successes and difficulties of which will be explored in Chapter 3. In Chapter 4, after assessing our findings concerning the measurability of the mind, we will be considering how what we have found can relate to perspectives concerning the mind-body problem, an area within metaphysics that concerns the difficult nature of understanding the place consciousness has with regards to physical reality.

Section 2: A Brief History of Measurement

Widely regarded as offering the earliest contribution to mathematical measurement theory is Euclid, the "father of geometry" whose ideas formed the basis for modern understandings of geometry, spatiality and physics, with plenty of his influence still evident today. He offers theory on magnitudes on his volumes entitled *Elements,* which in his writing are instances of a given length, area or volume, critically introducing the notion of ratios between magnitudes (*Euclid 2002*: *Book I)* and offering some of the first instances of formalised analysis and comparison between mathematical entities, though these magnitudes were initially represented algebraically rather than numerically (*Euclid 2002: Book X).* This concept of Euclidean magnitudes allow for mathematical comparison to be made between magnitudes, and provides guiding principles for the construction of measurement scales to represent objects and the relations that exist between them- much of the natural world appearing to us characterisable in this Euclidean sense, for instance we can assert that the mass of our moon compared to the Earth exists as a ratio of approximately 81:1, or that my running speed in relation to my walking speed exists as a ratio of 12:1. What these examples serve to indicate is that Euclidean principles can be used to describe natural properties at a vast scale far beyond the context in which Euclid had them initially conceived. Important to note is that while Euclid does make reference to measurability, in the context of his writing the term simply means to state that a magnitude has the capacity to measure another in this strictly mathematical sense of ratios (that a line x measures another line three times its length as $3x$ for instance). Euclid's sense of the word measurability is detached from the experimental connotations that we'd associate with measurement as an investigative procedure: he is not speaking of any empirical process of measuring a length with a ruler, only relations that exist between mathematical entities *(Mari, Maul et al. 2017: 118)*. Historically the distinction between measurement in this Euclidean sense and measurement as an investigative procedure has not always been so obvious, and this has perhaps contributed to the development of the more strict measurement theories that have seen to regard it as a necessary criteria for objects of measurement to possess something akin to this Euclidean character; discussion of other contributions to the field should shed some light as to whether or not a strict stance concerning objects of measurement is justified or arbitrary to some degree.

Ideas offered by Aristotle went on to provide the subject for debates that proved instrumental in the development of modern conceptions of measurement. In *Categories* (*Aristotle 1a),* Aristotle set out to formulate the categories of fundamental expressions which when used in tandem can be used to describe any given object encountered in experience (§4), though of the categories in general it's worth noting that there is still debate as to whether or not Aristotle is taking each category to refer directly to a corresponding fundamental feature of a given object or whether the categories are just linguistic tools to offer a comprehensive description of objects (*Yu 1999: 440)*, a point that mirrors debates about realism in measurement today. These ten categories, named *genus* on account of their fundamental nature, are all relevant to measurement in a broad sense though the categories of quantity and quality hold particular relevance to stricter modern measurement theories, described in Aristotle's *Categories* in *§6* and *§8* respectively. Quantity is a category that is divided into numerous subcategories including lines, surfaces, bodies (or solids), and numbers, with descriptors within the quantity category denoting different kinds of spatial or mathematical quantity (*§6*). Quality is a category that is somewhat broader than quantity, but of particular note are the qualities he describes as dispositions that give way to opposite pairings: he refers to hot and cold for instance, which today we would often characterise as polar ends of a singular temperature scale.

Aristotle's notion of quality in *Categories* prompted debate amongst medieval period thinkers who adapted his separately defined notions of quantity and quality (*Jung 2011: 553*; *Clagett 1968)*. Duns Scotus was a proponent of addition theory, reasoning that some qualities could be described using notions of quantity through construing a quality on a scale whereby the addition/subtraction of smaller degrees of the quality can signify its place on a gradient. This notion was further refined by Nicole Orseme, who observed that certain qualities could be represented as Euclidean magnitudes, allowing qualities demonstrated through observation of the physical world to be described and compared in a comprehensive sense mathematically, laying the foundation for early understandings of quantifiable laws of nature (*Grant 1996*). At this point it would be easy to regard Aristotle's *Categories* as simply being precursive to more complete forms of measurement, however categorisation should not so quickly be dismissed as not being a type of measurement in and of itself, and is a procedure that can articulate properties about entities that we would regard both informative and objective while not necessarily describing an extensive quantifiable character; if we are to deny the possibility of identifying a species of animal as being a form of measurement for instance then sufficient reason must be given for this restriction, otherwise there is a realm of objective information about our world that is unnecessarily denied a privilege that more robustly quantifiable properties are.

Before considering more modern theories surrounding measurement, there are thoughts regarding the two different classifications of magnitude put forward by Emmanuel Kant in *Critique of Pure Reason* that hold relevance to our considerations as to what realm of properties we might consider measurable. In following with prevailing thoughts surrounding addition theory and Euclidean magnitudes, Kant defines extensive magnitudes, the measurements of which describe the spatiotemporal form of an object defined by a successive concatenation of a given unit *(Kant: B202)*. Kant describes this type of magnitude as one that is the sum of a great many parts that form the whole unified extensive magnitude: the conception of my prize-winning squash weighing 5kg is founded upon the understanding that the 5kg total is composed of a succession of many smaller magnitudes of the same kind (1kg + 1kg +1kg etc…).

Kant describes the "axioms of intuition" which make possible our evaluation of extensive magnitudes: fundamental principles of geometry are hard-baked into the very mode through which objects of experience appear to us, Kant writes, defining such as the "transcendental principle of the mathematics of appearance" (*Kant: B206)*. This suggestion Kant makes that mathematical principles are features inherent to human perception and comprehension of objects rather than features expressed in objects as they exist in sense-separate reality is a topic that will be brought into discussion at various points of this thesis, Chapter 4 in particular, and one that has deep significance for how we are to regard the more mathematically-bound modes of measurement in the greater philosophical context.

The second kind of magnitude that Kant describes are intensive magnitudes, the type of which we'll be considering being those found within experience. Kant describes that the sensations we encounter within experience possess a given intensive magnitude (*Kant: B207)*, though not ones that can be subjected to the same quantitative treatment that spatiotemporally bound extensive magnitudes might be. Contrary to extensive magnitudes, the whole of an intensive magnitude is presented as a unified phenomenon, being indicative to us of a certain degree but not through virtue of concatenation of parts as we would expect of the former. For instance, you might scream when I drop my prize-winning squash on your toe; my experience of such gives me an impression that the loudness of the noise sits on a scale where the degree of the screams loudness is in some sense apparent to me.

Kant reasons that this is not a magnitude defined through synthesis of smaller parts but rather "through approximation to negation"*(Kant: B210)*, which to describe with this example means that the magnitude of the sound is defined roughly by how less intense the scream could be before it is devoid of any phenomenality at all. In comparing these two types of magnitude we can immediately see that we face a potential problem when facing the prospect of yielding informative measurements for intensive magnitudes: while you might be able to produce an accurate value for an extensive magnitude by placing a vegetable on a weighing scale, I might experience a feeling of jealousy that we could consider an intensive magnitude, a magnitude that is not so obviously measurable. I might be able to define this feeling in a non arbitrary manner (I was more jealous than many past instances of feeling a degree of jealousy), though without access to any procedure that could produce a shareable measure that meets a shared standard for objectivity I am unable to articulate the magnitude in a way that would be considered a measurement by any definition.

It is here that we are first introduced with a persisting issue within philosophy of measurement regarding mental properties: some properties of phenomenal experience give the definite appearance of existing on a scale (e.g. less jealous to more jealous, less pleasurable to more pleasurable), and thus it can be reasoned that they exhibit an ordering that hints to a degree of quantifiability. The problem here is that measurement procedures involve physical interaction in some way, and the prospect of reaching into the mind and directly measuring these properties as we would with physical ones seems inconceivable. Before further considering this notion, it will be fit for us to explore the strengths of measurement within the physical domain to better assess whether measurement, quantified or otherwise, is a process that can be directed towards properties within experience.

Section 3: Contemporary Measurement Theory

Modern measurement theory is an endeavour often intertwined with mathematical principles, and for the more strict measurement theorists who's conceptions of measurement have been heavily influenced by the physical sciences the question as to what we might consider valid objects of measurement is a question of whether such objects are representable in an appropriate mathematical framework. Norman

Campbell, a prominent measurement theorist and physicist, claims "the object of measurement is to enable the powerful weapon of mathematical analysis to be applied to the subject matter of science" *(Campbell 1920: 267-8)*, stating "all fundamental measurements belong to physics". Fundamental measurement operations are those that concern Euclidean magnitudes, ones that can emulate particular mathematical properties. What this requires, Campbell writes, is for a physical process of addition to be found for a magnitude that mirrors mathematical laws of addition, with not only "greater than" relationships being demonstrable between magnitudes but also addition via "concatenation."

This notion of concatenation is well understood with reference to Kant's extensive magnitudes, where there is a uniformity between the smaller parts that make a whole magnitude. A simple demonstration of this would be if I were to dice a rival's prize-winning squash into tiny slices and rearrange the pieces: no matter the configuration of the slices, the squash should be of the same weight as before, because the magnitude as a whole is indiscriminate towards how it's component parts are concatenated; a fundamental measurement is one of the magnitude as a totality, one where its parts are reducible to identical units. Demonstrable greater than relations make possible the non-arbitrary ordering magnitudes, but if a magnitude can also imitate concatenation operations then it can be characterised using uniform units that have Euclidean properties, and can be considered an object of fundamental measurement allowing the application of more comprehensive mathematical treatment.

Campbell makes clear that he considers fundamental magnitudes as the only properties suitable for treatment as measurements in the complete sense, proceeding to describe derived magnitudes which are magnitudes that obtain limited quantifiability through reference to existing fundamental magnitudes (*Campbell 1920: 283).* A prevalent example of such a magnitude is temperature, the measurement of which can only be obtained through two fundamental magnitudes: the volume and density of a body of mercury in a thermometer in a liquid thermometer, for instance. As a derived magnitude, different temperature measurements can be ordered and the increments between units are informative (1°C will always represent the same change in temperature across the scale), and so meaningful comparisons can be made between measurements of temperature, however being a magnitude that has no discovered empirical structure that mirrors Euclidean properties, its validity as an object of measurement is only to be regarded in a limited sense for Campbell, and it lacks the power of mathematical analysis including ratio relations that complete measurement can allow.

What is clear is that for Campbell true measurement has a very strictly defined place in our enquiries, and though stances such as this have been criticised as being overly restrictive and denying cross-disciplinary application, his high regard for fundamental measurements is justified, if not to the extent that it warrants such an uninclusive definition of true measurement. That mathematics provides a proven language with which we can accurately describe magnitudes in the natural world as well as subject them to extensive comparison and analysis is nothing short of incredible, serving to enforce the viewpoint that there is a detailed regularity to certain features of the physical world that fundamental measurement is able to directly capture. The mirroring of mathematical principles within our comprehension to these naturally occurring magnitudes certainly grants fundamental magnitudes a degree of exceptionalibility that demands further attention, however soon it will be fit for us to first look to opposing arguments to consider whether or not this justifies Campbell's strict definition of measurement.

Following a stance similar to that of Campbell's, measurement is the process of taking an observed magnitude and expressing it as a number on a scale, where the scale is a mathematical structure that allows numbers to represent magnitudes while preserving their relevant empirical relations *(Krantz et al 1971).* If a mathematical structure is capable of preserving all relevant relations in a given observed system then it is described as *homomorphic* (*Trout 2000: 266-7)*, and important to note is that different instances of homomorphism between a given mathematical structure and a set of observed relations involve the invocation of different mathematical operators in their description. We can refer to the example I raised earlier of weighing my prize-winning squash, and consider how when measuring weight in kg there are certain rules at play that make the description possible. Objects weighed in kg can be ordered in succession according to this measurement using Campbell's "greater than" relation, with such ordering of quantity being a fundamental hallmark of any valid measurement scale concerning quantity. In this particular scale we can also see that the zero point is non-arbitrary, where a description of zero kg would accurately reflect the complete absence of the given magnitude. This is significant to note because in other measurement scales, the types of which will soon be elaborated on this is not necessarily the case- for example the derived magnitude temperature in degrees celsius, where zero on its measurement scale does not represent a complete absence of heat.

More liberal measurement theorists have presented arguments supporting the validity of non-physical properties as objects of measurement, and developments in the field of psychology have seen theorists attempt to emulate the powerful abilities that measurement in the field of physics enables, one such theorist being S. S. Stevens, who presented a famous example of measuring the sensation loudness. Stevens reasoned that through utilising knowledge of the volume of a sound being produced as well as the density of the sound in effect you can reliably measure the degree of loudness experienced through the simple linear relation: *loudness = volume x density* (*Stevens 1975: 38-58)*, where he found that (predictably) the values yielded for loudness do indeed mirror reports of perceived loudness provided by test subjects.

Stevens puts forward a strong case against views such as those offered by Campbell, reasoning that sensations don't need to be "laid end to end like measuring sticks" (i.e for them to be recognised as a totality of uniform parts empirically) for them to be represented as values with Euclidean properties, and despite being a derived magnitude, experienced loudness can be placed on a scale that whereby an extensive range of homomorphisms appear to be at play: different values for loudness can be described in ratios where a measurement of 6 would indeed seem to represent double a measurement of 3 on the scale, and the zero point on the scale would be representative of a complete absence of experienced loudness. The points that Stevens makes give a solid account for the measurability of particular mental properties: they are construable in a manner similar to Campbell's derived magnitudes, and their representation on a measurement scale supports the idea that mental properties exhibit a regularity and structure that can be glimpsed upon through measurement if not in an entirely direct manner as we'd find with physical properties.

Section 4: Defining Measurement Practice

Having considered some varying views regarding the representation of properties using measurement, we now consider the four different scales that these differing objects of measurement can be modelled within that provide varying levels of mathematical description that are considered archetypal amongst measurement theorists (*Stevens 1946: 678; Trout 2000: 268-9).*

(1) a ratio scale, one where Euclidean properties are present and describe ratios and relations to a non-arbitrary zero point in units across the scale, concepts with which we have become familiar. Fundamental magnitudes within physics are obvious examples wherein their empirical structure can be observed to emulate these relations, but other properties (such as loudness described by Stevens) with demonstrable homomorphisms can also be represented in a ratio scale in a way that appears to cohere with Euclidean properties, though this is a topic for further discussion.

(2) an interval scale, one we've already described sufficiently with Campbell's example of temperature where there is a uniformity between units but they do not possess Euclidean properties (the ratio of 2:4 does not "measure" the relation between 2°C and 4°C).

(3) an ordinal scale where there is no non-arbitrary representation of units and the only mathematical relation that can exist between measurements is "greater/less than". An example would be if I were to report sensations of loudness and place them in order of intensity (in the absence of any pesky measurement theorist relating my qualitative reports to more mathematically robust measurements).
(4) a nominal scale, the final scale and one with the most limited capacity for mathematical comparison between elements being capable only of invoking the operator "equal to" between measurements is concerned strictly with categorising properties similarly to the way in which Aristotle sought to measure the properties of reality. If I am to place you in the category of "male" for instance, or if I were to categorise a particular fundamental particle as having a "positive charge" then in both circumstances I would be able to represent equality or inequality between other relevant properties measured similarly.

Given the wildly differing forms of measurement we've discussed, a degree of justification is required for them all to be considered a unified concept worthy of philosophical discussion in this thesis. Though not representative of the full range of ideas presented by other measurement theorists I feel that Campbell and Stevens offer suitably archetypal viewpoints for the purposes of this chapter, and though ideas presented by both are of significance to further discussion, I find strict definitions for measurement such as Campbell's that demand properties to be representable as Euclidean magnitudes and even relaxed definitions such as Stevens's "the process of assigning numbers to represent qualities'' (*Stevens 1920: 267)* unsatisfactory in providing a definition that captures the significance that measurement has in our enquiries when employed as a procedure to investigate reality. A more fitting definition reminiscent of the one offered in the introduction is that measurement is an "objective description of a [property]. The description is not merely a matter of opinion or feeling. It is invariant in rational discourse. [...] A measure of a property allows us to express facts and conventions about it in a symbolic language" (*Finklestein 2009: 1271)*. Finklestein's definition emphasises the intersubjectivity of the information that credible measurement procedures yield, and when we frame measurement in the way he describes we can regard our shared objective worldview as one that is facilitated through measurements.

Across mankind's development, we have refined the standards by which we hold measurement procedures capable of articulating objective properties about reality. Consider an ancient cavedweller looking outside and seeing a tree: within the relied standards for objectivity amongst his peers, he can yield a simple measurement, an intersubjective report that a particular object is categorised in the class "tree" representable on a nominal scale. Measurement today might be capable of articulating far more details about the same object: its DNA sequence, its physical properties and composite parts that demonstrate Euclidean character etc, however Finklestein's definition provides a context in which we can consider the underlying principle of measurement to be the same throughout history and domains of enquiry irrespective of our constantly updating theories: that measurements are attempts at articulating a property within our most reliable standards for objectivity. Following this definition, measurement practices represent our best efforts at articulating properties in reality as factual, allowing us to meaningfully discuss measurement as a practice detached from an absolute commitment to mathematical principles while still being able to consider the implications of a reality where some properties are more precisely spoken to us in the language of mathematics.

Section 5: Content of Thesis

In Chapter 2 we will consider how the character of measurement can be defined with regards to its place in our understanding. Measurement describes a world of properties beyond the context of subjective experience, and so sufficient arguments must be provided to support the notion that, in ideal conditions, measurements correctly describe a reality external to measurement practice. We will discover the inherent theory-dependence of measurement, a state of affairs that carries with it some particular obstacles with regards to how we can regard the capacity for measurement to articulate features about reality. After exploring challenges presented within Operationalism and Conventionalism, we will see if a sufficient realist argument can be found- a stance that will need to overcome the changing contexts of understanding that measurement practice finds itself intertwined with.

In Chapter 3 we will direct the question of measurement towards a particularly difficult to measure area of properties, that being the human mind and the contents of experience. A central area of concern is that of direct measurability, and the necessary involvement of physical proxies to facilitate measurement of mental properties. After discussing ideas contained within psychophysics, we will explore the measurement of particular mental properties, including experience of colour and pleasure. Measurement provides an incredible capacity to describe the structural features of reality, features that also seem reflected by the ways in which we experience particular mental properties. We will see how successful measurement is as an investigative procedure when directed towards the contents of experience, assessing the difficulties measurement finds itself encountering inherent to the domain.

In Chapter 4, we will consider our developed understanding of measurement with relation to the greater context of reality we find ourselves experiencing, discussing an area of philosophy known as the mind-body problem. The descriptions of reality that measurement provides can provoke the intuition that reality is fundamentally physical; that we exist in a world definable strictly in terms of its measurable physical properties. However, problems arise when we try to account for the emergence of consciousness against this backdrop of otherwise non-conscious matter. Through exploring several notable stances concerning the mind-body problem, we will try and develop a better understanding as to how it is that reality appears to contain both experienced mental properties and measurable physical properties.

Realism in Measurement

Section 1: Introduction

Stances of measurement realism are positions that take the view that measurements have the capacity to describe properties that exist in reality. If I were to weigh a mass of feathers on a scale for instance, a realist would say that the number on the scale tells us something tangible about the weight of the feathers as a property independent from the measurement procedure. Most of us have a common-sense belief that measurements, whether obtained firsthand or by others and built into our existing theories about reality, are capable of referring to properties that exist outside the flow of experience we find ourselves in, and most of us are unknowingly measurement realists by default. In the previous chapter we considered how measurement might be broadly defined to incorporate a wide range of practices that we would typically associate with measurement as an investigative procedure; in this chapter it will be necessary to consider a form of General Measurement Realism (which I will refer to as GMR), investigate the various issues faced by GMR that support an anti-realist case against the realist, before considering a suitable response to the problems associated with GMR in the form of Structural Realism and Fixed Point Realism (FPR). Within many spheres of modern thought including much of the scientific community where our most complex theories about reality are described, a commitment to scientific realism and by extension some form of measurement realism is generally accepted subconsciously. The question of how measurements encountered in experience can refer to properties beyond the horizons of the mind is generally not a question that is seriously considered a threat to the foundations of our ever expanding scientific worldview, despite its answer being far less clear than some would expect.

Section 2: Estimation and Operationalism

GMR is a broad approach to measurement realism that defends the position that measurements can articulate information about real properties through proven and tested estimation of properties and their relations (*Trout 2000: 272; Mitchell 2005: 287)*, with any fault in estimation being explained by human error, imperfect measurement procedures or incorrect background theory. The GMR theorist maintains that measurement does have the capacity to describe independent properties, though through these potentials for error measurement can only ever be a process of estimation, even as our measuring capabilities might become increasingly refined. The definition for measurement arrived at in the last chapter is one that coheres with GMR but takes no definitive stance on the realism debate at all: "a description of a property that is made within our most reliable contexts for objectivity" establishes measurement practices as defined through rational discourse, and leaves intact theories about measurement that would deny the ability to define any realist character within measurements.

Operationalism is one such theory, and the distance between measurement and property as made evident through the GMR theorist's definition of measurement as a process of estimation is something that the Operationalist takes exception to. Percy Bridgman, who was the first and most prominent contributor to Operationalism, wrote from a perspective influenced by Logical Positivism and accordingly sought to define the character of measurement completely stripped of the metaphysical commitment that measurements refer to reality beyond the empirical context of measurement operations (*Bridgman 1927: 5)*. For the Operationalist, there is a leap-of-faith involved in GMR when it is claimed that measurements can represent measurement-independent properties, and he refuses through strong empiricist principles that measurements can be defined to be referring to any such property at all.

For Bridgman and other Operationalists, a token yielded as the end result of a measurement procedure (a number on a weighing scale, a colour value read from a spectrometer etc,) is defined entirely and solely by the measurement procedure that yielded it. In following Operationalism the measurement "1kg" obtained through weighing feathers weighed on a mechanical scale is not an estimate of the independent, external property of "weight" as a GMR theorist might maintain, but rather the token "1kg" can only be said to refer to the entirety of its associated measurement procedure: the exact circumstances and operation of the feathers being placed on the scale; nothing more, nothing less. Following Operationalism, different attempts at measuring the same external property will by definition always yield different measurements: the measurement of 1kg of feathers using a mechanical scale will be an entirely different export to a measurement directed to the same feathers using an electronic scale. For the GMR theorist these two different attempts at weighing the same feathers using different weighing scales would both yield estimates of the same property- for the Operationalist each yielded measurement is completely individuated.

The ideas raised by Operationalism are generally considered a poor alternative to GMR and measurement realism in general, and the theory itself has faced harsh criticism that damns it to failure. Firstly, no criteria is offered for the accuracy of measurements (*Gillies 1972: 6-7*): with the theory concerning itself with nothing beyond measurement procedures themselves, Operationalism makes measurement seem an arbitrary practice that is stripped of any meaning. A measurement doesn't equate to anything other than "token I obtained using one entirely particular procedure", and being that this definition is self-evident, any given instance of measurement is not permitted to tell us anything informative about reality at all beyond each measurement being a product of the exact conditions that yielded them. What this seems to do is to hold measurements in a light that denies them any distinguishable features from any other interpretation of physical phenomena: your physical form as it sits or stands reading this sentence now might be described as merely a product of specific circumstances; the operationalist does not regard measurements as having any special properties beyond this example offered, and measurements exist with no criteria for success at all.

The second issue for Operationalism is that the essential definition for a given measurement procedure/operation is not one that can be arrived at particularly easily: are we to include all contributing factors that might have had an impact on the outcome of the measurement (the temperature of the scales, the passing of a massive celestial object etc) in this definition? With the particular circumstances in totality providing the sole and exhaustive definition for each measurement, sufficient clarity as to what constitutes an operation of measurement is essential, more than has been given within literature regarding Operationalism (*Chang 2009: 2.3*). In any practical context, the Operationalist denies himself the ability to make any realist claims about measurements via his conception at all: it follows that measurements of some kind would be required to identify all the various factors and variables that a given Operationalist instance of measurement is defined by, and while pragmatism is clearly not a concern of the Operationalist this idea does serve to demonstrate how Operationalism very much backs itself into a useless corner.

Operationalism has been near-universally discarded as a theory that can provide an alternative to GMR and other forms of measurement realism. A conception of realism that would satisfy the Operationalist's strict empiricist demands would require an "impossible God-like view in which nature and theory and measurement practice are all accessed independently of each other" (*Van Fraasen 2008: 139)*. We do not find ourselves experiencing a reality where the mind-separate properties we direct our measurement efforts towards can be apprehended in such a direct and infallible manner, and the success and efficacy that measurements offer in our endeavours gives a far more positive case for the GMR theorist's conception of measurements being estimates of real properties rather than the Operationalist's refusal to admit that measurements can describe these properties at all.

Section 3: Theory Dependence of Measurement

GMR finds itself encountering a range of problems through a complete dependence on greater theoretical contexts that instances of measurement are required to make reference to. Measurements do not exist in a vacuum, and require peripheral theories to interface with: any conception of a measurement procedure that exists without dependence on any theory is a procedure that would be deemed unable to yield measurements meeting any criteria for objectivity within rational discourse, and certainly not with any defensible degree of realism. Raymond Tallis articulates the reasoning behind this:

> Theories are tested by measurements and the instruments to make measurements possible are themselves built according to a nexus of theories that pick out the parameters that are measured and underwrite the connection between what is seen on the dial and what is being measured (*Tallis 2018: 122).*

Tallis highlights the fundamentally holistic context that theory and measurement find themselves in, where both provide and derive meaning from one another in a circular sense. We can consider a simple example: perhaps I am deciding to finally categorise the animals that live in my home according to species, carrying out a rudimentary measurement procedure fit for representation on a nominal scale. I consider the physical features of my animals and make a measurement that the first animal fits within the "dog" category through virtue of his waggy tail and loud bark. This measurement is only yielded by utilising facts and ideas about what properties objects described under the category of “dog” are defined to have in a surrounding context of theory, and similarly all theory surrounding the category of “dog” is born out of instances of measurement, be they rudimentary or otherwise.

Most modern measurement procedures subject to serious discussion rely on a far more layered background of theory: precisely categorising a species according to it’s genetics requires immense knowledge of the role DNA has in the development of life for instance, before even considering the theories required to identify, make sense of and measure microscopic structures of DNA. Properties more classically regarded as objects of measurement such as mass and temperature are no different, and the fundamentally ever-changing nature of the background contexts that facilitate valid measurement as scientific and theoretical thought continues to develop is where we find the first problem GMR faces in light of theory-dependence, that being the “Problem of Theory Change”. This problem is one that measurement shares with scientific realism as a whole, the most famous outline being offered by Larry Laudan (*1981: 26-8*), who made the observation that the success of a theory has never been dependent on its ability to describe features of reality correctly. Of the numerous examples he raises, Laudan makes reference to the theory of vital force, the notion that certain substances can only be created by God-given creatures and not through artificial means. The theory postulates that God’s living creations are alone in possessing “vital force” to generate such substances, and this theory did successfully articulate properties about reality according to our current theories in the sense that certain organic compounds are generally only synthesised through biological processes in living organisms. Laudan proceeds to reason that there is a tremendous likelihood that most of our modern theories about reality are false despite proving successful in our endeavours via a commonly cited argument within philosophy of science known as the Pessimistic Meta-Induction. In turn the entire background of theory that the GMR theorist relies upon for his claims that measurements are estimates of independent properties is left on incredibly uncertain grounds.

Another problem for the GMR theorist raised through theory dependence is the "Contrastive Underdetermination Argument" that follows similar reasoning. Though the argument has taken various forms over the years, it is best understood generally as the following: for any given successful scientific theory and/or set of measurements that cohere with our interrogations of experience, there are always alternative theories and measurements that can be constructed that would explain the phenomena just as coherently. The argument's earliest prominent contribution came from Pierre Duhem, who noted that in matters of geometry we can consider two opposing theories as raising a simple case of mutual exclusivity: if one is proven false, then the other is necessarily true with no room logically for theories alternative to the two in question. On the contrary Duhem writes of scientific theories:

> Do two hypotheses in physics ever constitute such a strict dilemma? Shall we ever dare to assert that no other hypothesis is imaginable? Light may be a swarm of projectiles, or it may be a vibratory motion whose waves are propagated in a medium; is it forbidden to be anything else at all? (*Duhem 1906: 189*).

For Duhem there is a case of underdetermination regarding which information is correct for us to build our scientific theories upon, and as a result we are left unable to say whether a given scientific theory is superior to another different theory that fits with our understanding just as effectively.

Writing during a time of intense theory-change in the field of physics, Duhem famously criticised Einstein's theory of relativity on the basis that it "has turned physics into a real chaos where logic loses its way and common-sense runs away frightened" (*Lakatos 2001: 21)*. Early relativity theory was not at all coherent with the existing scientific theories of the day, and through Duhem's denial of this new scientific theory we can see an example of the dynamism of theory-change at play. The argument stemming from Duhem historically lost prominence on the grounds that it consists of purely theoretical and a priori reasoning; it isn't greatly troubling to scientists that alternate theoretical contexts can be constructed to explain phenomena, just as thought experiments such as the idea of not knowing whether or not you're not a satisfied pig in a vat being artificially stimulated: Duhem's argument in isolation doesn't provide a positive case for our current theories to be false, though is worthy of attention nonetheless, but when bringing the problem of theory change into the fold Duhem's reasoning holds greater weight.

Kyle Stanford makes a connection between these ideas via his "Problem of Unconceived Alternatives" (*Stanford 2006: 17-20)* on the basis that it has been proven beyond principle that the majority of theories across time that would have been coherent at the time of their devising have been discarded for alternatives;

Stanford sees the arguments developed in this way in his writing, and forms an argument incorporating underdetermination with some modern relevance. The problem Stanford's argument offers to the GMR theorist is that he is left having to face the proven likelihood that the definition he holds for the independent property that any given measurement seeks to estimate is actually not reflective of any real property at all. The GMR theorist might be estimating a particular property, but he is left unable to make any strong claim about what that property actually is.

For the final issue that GMR faces concerning theory-dependence, it is necessary to consider a problem concerning the relationship between measurement practice and theory. Eran Tal outlines the problem of coordination and he establishes his reasoning as follows: the adequacy of a measurement scale/framework to represent a property and the reliability of a measurement procedure to describe a property are two conditions that find themselves presupposing each other in a circular way (*Tal 2013: 1160).* If I am to devise a theory of mass for instance, I am required to have a reliable procedure to measure mass as a property, however to determine whether such a measurement procedure is reliable, I am required to have some background on a theory of mass (relations with other physical forces etc). The problem of coordination is a case of circular presupposition where, in principle, it seems a logical impossibility for either theory or measurement to precede one or the other, while also seeming completely necessary that one must precede the other. Tal's problem serves to demonstrate that measurement and theory are developed organically and via pragmatism: the development of measurement and theory does not face itself with any critical roadblock in spite of the Problem of Coordination, and the efficacy of a given connected measurement and theory is what grants its reverence in our developing understandings, *not* some instantaneously proven bond between measurement and theory that denotes that the pairing is of a realist character. Tal's problem of coordination highlights a detachment between tokens of measurement yielded through measurement procedures and the properties that measurements attempt to estimate, and calls to question how forms of realism such as GMR can be justify the theory base that they necessarily dependent upon, being that neither measurement nor theory can develop without this case of circular contingency.

Section 4: Tokenization and Conventionalism

To demonstrate the final problem that GMR faces before concluding that GMR is an unsuitable form of measurement realism, we must consider tokenization. The standard postulated by GMR theorists is that correct measurements yielded as tokens, whether numbers or other values, are able to describe a property as it exists in reality with some degree of accuracy. When we examine the GMR theorist's entire process of successful measurement, from the property affecting the measurement apparatus to the end result of some degree of accuracy, we yield as the final product a token that we experience as an instance of language (a number we record from a pressure gauge, a single cataloguing of a species entered into a nominal scale etc.) The problem faced for GMR when we consider measurements in this way is one shared with language as a whole when considering matters of reference, that being Semantic Instrumentalism, a problem traditionally cited by logical positivists .

Instrumentalism regarding language (including measurements yielded as tokens) is the stance that any given term is employed not through knowledge that a given token corresponds to an object or property in reality with some degree of accuracy, but instead because they prove practical in our endeavours (*Neufville 2020).* When you or I look out the window of the bottom floor of our bungalow and observe a plant that we would categorise as a "palm tree", we are using the token "palm tree" to describe the object through virtue of the rich and layered history of the English language and how through practical means we have come to categorise types of trees and associate them with particular identifiers. Similarly, as best outlined by "the McLeish problem" (*McLeish 2005: 667-85)*, Christina McLeish argues that there exists no conceivable standard by which to determine whether or not tokens of language (including measurements) can be said to be referring to an object/property in reality with any degree of accuracy at all.

So what makes Semantic Instrumentalism problematic for the GMR theorist? Given that any yielded value of a measurement is a token of some description (a quantity expressed with Euclidean properties, a category of object, a number used to denote some non-arbitrary ordering across a scale etc), naturally we must concede that the principles of Semantic Instrumentalism apply to instances of measurement being that they are tokens. This offers another angle through which we can consider the detachment between properties being measured and the tokens of measurement yielded by procedures, one resonant with all forms of language, that being that measurements can only ever be said to exist within the nexus of knowledge and theories collectively held within human minds. The problem for the GMR theorist is that when we consider measurements in such a way, it seems there is no way to bridge the gap between a yielded measurement and the external property it is trying to articulate, with measurements appearing to be left with no capacity for tangible reference at all.

Conventionalism is a theory concerning the character of measurements that can be used as a response to the concerns raised via Semantic Instrumentalism, and while not strictly an antirealist theory of measurement, it offers no support for the GMR theorist. Similarly to its less successful cousin Operationalism, Conventionalism is an empiricist theory of measurement that seeks to define measurement through empirical means. Though having featured a range of interpretations and contributors, Conventionalism can generally be understood as a theory that describes the character of measurement as one defined strictly by conventions dictated via pragmatic concerns (*Trout, p271-2)*, rather than measurements having any necessary realist character as the GMR theorist would argue. Of the stronger suggestions offered by Conventionalist thought are that the very framework of geometry that we use to contextualise many measurements in space are defined by convention rather than truth values, a notion that can be traced back to early works within Philosophy of Science.

Arguably the strongest case for conventionalism can be traced back to the time of its origin: Helmholtz presents a thought experiment popular at this time about a land inhabited by creatures known as "Flatlanders" that can only perceive in 2d, with the land imaginatively named "Flatland" (*Helmholtz 1876).* Unknown to the Flatlanders, Flatland actually exists in space as a sphere describable in a Euclidean sense with 3 dimensions akin to our own, and when they traverse one end of

Flatland to the other, while they think they are travelling in a straight line across a 2d plane, they are actually travelling in an arc in 3d space across the spherical surface of Flatland. Important to note is that the measurements that Flatlanders use to measure their world will rely on principles of geometry that are incomplete and not representative of the the 3d Euclidean reality that they inhabit: if two Flatlanders were to set out on a journey across their land some miles apart stood parallel, their paths would never intersect if we are to follow the 2d theories about their world. However, the Flatlanders would be making an incorrect conclusion, and when travelling across Flatland as it actually exists as a sphere, the arcs made across the surface when two journeys are made will *always* intersect at a given point, demonstrating how incomplete theories born of the highest degree of conventional pragmatism available can prove sometimes ineffective in yielding correct measurements.

Torsten Wilholt offers a crucial point concerning this example of the Flatlanders, suggesting a possible scenario wherein the Flatlander's theories might have developed principles of geometry where they can make entirely coherent claims about the 3d Euclidean reality they inhabit (*Wilholt 2012: 32-52).* Suppose that the Flatlanders do indeed inhabit a 3d land, but only derive their convention-born theories and measurements from an extremely tiny area of a sphere. Wilholt raises the point that, if they were to inhabit a suitably small section of their spherical world, this small area would mimic a 2d plane so closely that the differences would be negligible; the Flatlander's measurements and theories *would* be indistinguishable from those devised via empirical means granted via experience of reality in a more comprehensive 3d sense. By Wilholt's reasoning very similar phenomena could be taking place when we consider the apparent coherence between our measurements and the world we see presented before us, and it seems difficult to reason that our measurement procedures and the conventions they depend upon are decided upon in a sense that has any strong ties to realism, rather than strictly pragmatic concerns.

Conventionalism as an area of thought within Philosophy of Measurement has a vast amount more contributions than covered in this section: concerns regarding the coordination of non-empirically verifiable rules essential to measurements as dictated by convention (*Carnap 1966: Chapter 24)*, and what pragmatic concerns deem a given scale or apparatus appropriate for representation and measurement of a given property over other means is glossing over a few. The most important idea offered within conventionalist thought in relation to realism is that offered previously by Helmholtz, one that has been elaborated upon by Joel Michell. Speaking of the same limitations faced by the Flatlanders, Michell raises the idea that were our sensory apparatus to be entirely different, our perception of the external world would be unrecognisable to that which we know, and our empirically derived principles of geometry would be completely different (*Michell 1993).* Attributes that we would otherwise recognise as extensive (weight, length etc,) might not be made knowable to us as such, in the same way that a Flatlander would scratch his flat head if you were to suggest that he measure the depth of an object.

Via Semantic Instrumentalism, and the ideas raised in Conventionalist thought, made yet clearer is the disconnect between measurements as tokenized language abstracted empirically and external properties. Conventionalism casts doubt on the notion that the way we make measurements via empirical observation can derive representations of independent properties in a comprehensive sense, being that the phenomena we experience may not be capable of representing the full extent of properties that exist in reality and how they relate to one another. In the same vein of the Flatlander thought experiment, there might be facets of reality that are utterly imperceptible to us that limit our ability to formulate correct theories of geometry, and by extension measurements. For measurement realism to be accepted to any degree, the realist will need a theory that can explain how it is that measurements can in any way be descriptive of reality while denying the significance of these problems, something that GMR fails to succeed at.

Section 5: Coherentism and Fixed Point Realism

Much needs to be accounted for in pursuing a form of realism about measurements, and so it is no surprise that throughout philosophy of measurement many thinkers have come to regard measurement realism in a severely limited sense, or outright deny we can prove measurements are articulating properties in reality at all in light of the problems presented in this chapter. Being that measurements are defined within ever-shifting scientific theories, and yielded through conventional contexts shaped by pragmatism and the limits of human senses, it seems difficult for the realist to find any firm ground.

An argument that seemingly sidesteps these problems can be found in a classically cited argument for scientific realism, the "No-Miracles" argument as described by Hillary Putnam: "The positive argument for [scientific] realism is that it is the only philosophy that doesn't make the success of science a miracle" (*1975 73*). However, efficacy, coherence and the appearance of progressive epistemic success do not always entail that a given theory or measurement is necessarily veridical, as can be recalled from arguments seen in this chapter such as the Pessimistic-Meta-Induction and the Problem of Unconceived Alternatives. Larry Laudan clearly outlines how these features of theory are often independent of one another (*1981: 45*), reasoning that approximate truth of a given theory and it's success in correctly referencing to features and properties in reality are neither necessary conditions for a theory to feature predictive success and efficacy, refuting any claim that realism need be adhered to explain these successes of our theories and measurements.

In looking for a stronger argument for measurement realism that doesn't fall prey to these pitfalls, it would be fit for us to consider the work of John Worrall, one of the earliest contributors to a theory known as Structural Realism, before looking at a variation on this theory known as Fixed Point Realism. Worrall writes using an example of theory change, where understanding of electromagnetic fields had shifted in contemporary physics:

> This was much more than a simple question of carrying over the successful empirical content into the new theory. At the same time it was rather less than a carrying over of the full theoretical content or full theoretical

> mechanisms (even in "approximate" form) ... There was continuity or accumulation in the shift, but the continuity is one of form or structure, not of content. (*1989 117*)

The specific example Worrall speaks of is concerning the overhaul of elastic solid ether theory to the theory of the electromagnetic field, where a vast range of features and referencing terms/ideas from the former theory were completely shed in adopting the latter. However, Worrall identifies a persisting element seemingly more fundamental than the expanded theory and content that instances of measurement find themselves dressed up in, this being the structure and form underlying each theory.

Following a sense of realism about structure, we can see that when one theory overhauls another they both demonstrate epistemic success in a way that is relative to their specific points of development, but the abandonment of terms and theoretical context through theory change does not necessarily entail that we abandon a sense of realism concerning structure and form, elements that can persist when a theory is overhauled. To provide a clear example to demonstrate Worrall's ideas, we can consider a simplified history of our understanding of mass and weight as properties. Weight might have once been considered simply an intrinsic property of objects, subsequently the effect of gravity on the mass of an object, and later on the effect of the fabric of space warping in relation to mass. Despite the fact there is very little persisting conceptually across these theory changes, measurements using bronze weights in Ancient Greece would demonstrate relations in structure that cohere with measurements made of weight today, despite the fact these measurements are framed to describe entirely different properties within theory. This kind of realism about structure allows us to reason that older theories about reality, and current falsifiable theories held today, can be describing underlying relations in their structure via measurements.

However, this simple form of Structural Realism still finds itself potentially vulnerable to issues in securing the realist's case, identified by Alistair Isaac as two distinctive epistemic loops (*2019: 2-4)*- these deny true realism and support a sense of Coherentism about measurements, wherein the only criteria for successful measurement practice is found internal to theory and areas of interest. For the realist, Coherentism should be avoided at all costs as it defines the character of measurements in strictly empiricist terms, and at best only goes so far as to say that measurements *appear* to be articulating information about properties independent from measurement, taking no positive stance on the metaphysical realism of properties as they exist beyond our theories and yielded measurements.

The first epistemic loop Isaac describes is epistemic iteration, the notion that the progression of theory and measurement are determined entirely by internal criteria relative to their contexts of interest. Though we might have come to refine and improve the measurement apparatus and procedures we employ to weigh objects, the only standards for truth we have to assess our successes at weighing objects rests "first and foremost on coherence with the rest of the system" (*Chang 2012 242*). Crucial to note from is that when we make the realist assumption that an iteration of a weighing scale is an improvement on a former in the sense that the number on this scale is better describing the independent property of weight of an object, an entirely non-empirical assumption is made- one that Chang and other more Coherentist thinkers find objectionable, choosing to define the successes of measurement entirely within the closed context of theory.

The second epistemic loop that Isaac describes is one concerning calibration, that being the process whereby a measurement device is corrected for errors made in yielding its target value, and models. It seems in our most refined efforts of measurement, many of which comprise of theory, apparatus coordination and epistemic achievement unimaginable to earlier humans, much of the measurement practice involving empirical contact with properties finds itself worlds away from the aspect of measurement involving modelling (*Parker 2017: 3-6*). Eran Tal (*2014: 297-304*) puts forward an example concerning the measurement of coordinated universal time, or UTC, that demonstrates this particular issue with models, as well as with calibration that Isaac describes.

An immense amount of theoretical models are depended upon for the yielded measurement of UTC, a value which is obtained through measuring the time of transition between two states of a caesium-133 atom at zero degrees kelvin- this transition of state is not something that can be measured directly, rather many physical models are employed to derive from less exact conditions how long this specific transitionary period might be. To speak the obvious, scientists aren't detecting this caesium atom wink over from one state to another in any direct sense at all, in fact a caesium-133 atom can't even be probed at this idealised temperature, Tal states, and such adjustments for discrepancies are made at many points based on our models of understanding, demonstrating the many degrees of separation between the empirical act of reading a particular measurement value and the potential reality of this time span between states of atom.

The process of measuring UTC involves calibration via the employment of a great many atomic clocks, the efforts of which seek to articulate the specific ideal transitionary period mentioned. All clocks are used to calculate an average, with specific clocks being more weighted to the final average based on their previous accuracy in yielding the final value of UTC. What might seem obvious in this example already, is that this weighing of values necessary for our current best procedure to measure UTC results in clocks that aren't stable relative to this property of UTC as it might exist as an actual property in external reality, but rather clocks that are stable to *each other* (*Tal 2014 302-4)*. Similarly to his first example, Isaac's second epistemic loop sees the success of measurement dependent on coherence with factors internal to contexts of theory and interest, in this case the models that are employed to yield meaningful measurements in the first place, as well as the modes of calibration we utilise which seem ever removed from the external properties that a realist would claim to be measuring.

Before considering Isaac's Fixed Point Realism as a response to the Coherentist concerns offered, it is important to regard his definition of successful measurement, articulating real, objective facts about the world. He defines "I take measurement to be any empirical procedure for assigning points (or regions) in a metric space to states in the world" (*2019: 5)*. Critical to note is that Isaac defines a metric space as "any set of elements with a distance metric defined over it", which equates to him only considering valid objects of measurement being those representable in an interval and ratio scale, and *not* those presented in an ordinal or nominal scale. This particular point is something that will be further discussed in the next chapter in regards to the realism of both mental and psychological attributes as objects of measurement, being that theorists may find certain instances of such attributes representable in these less descriptive scales. Having shelved this particular discussion for now, we can consider two features that Isaac considers vital for successful measurement, that together deny the Coherentist his concerns and demonstrate a realist character to measurements within the framework of Fixed Point Realism.

The first feature necessary for successful measurement that Isaac describes is convergence, a principle that isn't new to greater scientific realism, with Hillairy Putnam claiming "the mature sciences do converge . . . and that convergence has great explanatory value for the theory of science" (*1978: 37*). Isaac speaks of convergence in a sense specific to measurements, whereby multiple instances of different measurement procedures are employed to measure the same external property, filtering out the model and theory sensitive features that measurements find themselves dressed in (*2019: 5-6).*

To demonstrate, I might be driving my new car down the newly built motorway that stops off at the Andromeda galaxy, with my in-built speedometer reading 80,000m/s. Meanwhile, my scientist lover sits on Earth with her telescope, observing the colour of my car from a distance and measuring the corresponding red-shift, a phenomenon of colour-change that occurs when viewing fast-moving celestial objects that indicates their speed. Between the speedometer and the spectrography offered by the telescope, the same measurement of 80,000m/s might be attained, despite both means of measurement employing entirely different models in our understanding. Convergence of measurement such as this allows us to consider the success of measurement beyond isolated instances of coherent epistemic iteration, and instead, the numerous different models and procedures are demonstrated to be arbitrary elements that can be stripped away to highlight a common measured property that exists in reality.

The second feature that Isaac describes for successful measurement is precision, namely of the type that is suggestive of stable properties in reality (*2019 6-9).* Isaac writes that in instances of successful measurement, the properties concerned must be capable of exhibiting a degree of regularity independent from the models being employed for the measurement- properties we would consider appropriate for representation in ordinal and nominal scales might not be capable of demonstrating such model-separate regularity. For instance, consider the categorization of Pluto, concerning whether or not it is considered a planet: the definition employed for the category of "planet" is wholly determined in theoretical terms in ways that can be considered arbitrary (*Slater 2017: 1-10).* If it were to suit the governor of Pluto for tax purposes, the category of "planet" could be expanded so that Pluto meets the criteria, as the category is determined wholly through conventionalist means.

The problem of semantic instrumentalism is highlighted with this example, where "planet" is a term grounded only in the context of human thought; Isaac writes that on the contrary, properties that can be measured with precision have success criteria that logically precede the theory and practice that are employed in successful measurement. We can think in terms of Euclidean magnitudes, and consider that when measuring the length of a piece of string, the algebraic relations across the measurement scale of “length” are already instantiated by the piece of string: a correct measurement for half the length of string is not open for the same case of categorical gerrymandering by my string-theorists as the definition of “planet” has, and our ability to consistently measure length as a property with increasing degrees of precision across successful iterations of length measurement indicates that it is an objectively fixed property with a true value independent from matters of convention and coherence.

Finally, we can arrive at Isaac’s theory of Fixed Point Realism (*2019: 9*), a variation of Structural Realism that finds itself able to respond to the array of problems that the realist might face. When a measurement of a property demonstrates both convergence and precision, we can deem the measurement successful and capable of characterising its magnitude across a measurement scale, or metric space as Isaac aptly refers. A key way in which Fixed Point Realism differs from the basic variation of Structural Realism described previously is that it commits itself to the ability for measurements to describe structural relations in a strictly algebraic sense, but *not* necessarily numerically- just as FPR and Structural Realism acknowledge that the models and theory a particular successful measurement finds itself dressed up in could be discarded, FPR goes further and argues that the particular mathematical account of relations interpreted in measurements may also be subject to similar overhaul. FPR is a theory that supports a realism about measurements by detaching measurements from theory (following Isaac’s criteria of convergence and precision) allowing us to extract the underlying realist, relational character that measurements have.

FPR offers a viable stance of realism about measurement, one that is entirely acknowledging of the factors outlined by empiricist, conventionalist and coherentist thought, but not denied a capacity for realism through problems these stances can raise via theory-dependence. The concepts and theories that surround measurements are indeed vital in practice, otherwise measurements are stripped of any meaning or context in our enquiries- despite this, realism about theory and models are *not* guaranteed as would be in broader forms of scientific realism, leaving behind a defensible form of realism about the capacity for measurements to describe structural and relational properties in reality.

Measuring the Mind

Section 1: Introduction

In previous chapters we have primarily considered the measurement of physical properties in reality: the weight of an object, the length of my housemate's neck hair, the frequency of a particle's oscillations etc. Measurement as an investigative procedure finds itself more often looking outwards, beyond the senses of a single experiencing subject and into the hypothesised external objective world; in our current efforts, precise information about the physical world and its regularities appear to be far more accessible and discernable via measurement practice than mental properties and their intricacies are. We are faced with a problem of direct measurability when considering mental properties, insofar as we are unable to reach into the contents of subjective experience and directly measure magnitudes and dimensions of the mental in the way we might with a tape measure or weighing scale inside mind-separate physical space.

In this chapter we'll be considering various scholars' attempts to describe ways in which we might consider mental properties measurable, including ideas raised in the field of psychophysics. Following this, we'll be considering the validity of measurement practice that uses physical measurements as a proxy to ascertain measurements about mental properties, considering whether such modes of measuring mental properties meet the criteria for valid measurements and whether they are fit for robust mathematical representation as described in the previous chapters. To conclude, we'll assess to what degree measurements of mental properties are capable of demonstrating the previously discussed criteria for realism regarding measurements of the mind's structure and mental properties.

Section 2: Early Psychophysics

When faced with this problem of direct measurability, the fact of the *what-it-is-likeness* of experience is something that is fundamentally private to the creature having that experience (*Nagel 1974: 437*), and this is a core concept within modern philosophy of the mind that will come into discussion next chapter. Within measurement, an attempt to navigate this is found with psychophysics, a field that responds by using the measurements of physical properties to indirectly yield measurements of mental properties. Early prominent contributors to the field investigated the relationship between sensations and the physical stimuli that produce them, identifying certain regularities that mental properties appear to exhibit in light of certain experiments. Gustav Fechner, who coined the term psychophysics wrote:

> Insofar as sensitivity is a variable, we should not seek for a constant as its measure. We may, however, look for (1) its limits and (2) its mean values; we may also investigate (3) how its variations depend on conditions; finally we may seek (4) lawful relations that remain constant during variation; the last are the most important. (*Fechner 1860: 45*)

Here Fechner outlines his fundamental process for studying mental properties, in particular the sensitivity of a given experienced sensation, when only the physical conditions that produce the sensation are able to be measured: *(1)* and *(2)* refer to Fechner's rudimentary process of quantifying sensation in relation to stimulus. In his experiments, the smallest difference in stimulus required to cause any increase/decrease in reported degree of sensation represents the "just noticeable difference" for a given sensation; in other words how sensitive a given sensory faculty is to the change of an associated stimulus. For example, I might invite you into my walk-in freezer while I stand on the outside, asking you to announce when you notice a change in temperature. Then, when I very gradually decrease the temperature until I hear your announcement, I can yield a just noticeable difference: how sensitive your perceptions are to the physical change of temperature in my freezer.

While the sensations themselves aren't made the direct object of measurement through this method, Fechner writes that we can *(3)* identify relationships between a given sensory faculty and stimulus variable by identifying this just noticeable difference. Most importantly, through repeated experimentation and identification of such relationships, methods within psychophysics can *(4)* identify regularities and constants concerning sensitivity to physical stimuli that might be present across many sensory modalities, and it's this achievement of Fechner's psychophysics that needs to be closely considered; if experiments within psychophysics can show that there are laws between between physical stimuli and sensory experience that remain constant through variation, then we are able to demonstrate a degree of quantifiability about these mental properties through association with these laws, in a manner not dissimilar to Campbell's derived magnitudes from Chapter 1. Before considering why this is significant to mental measurability, we must look at the work of Fechner and his contemporary Ernst Weber to see what kind of laws implicating the senses are discovered via psychophysics.

Weber's writing was foundational to early psychophysics, and he made the claim that a particular rule is present between a given sensation and associated stimulus when considering a wide range of sensory modalities. This rule was later dubbed "Weber's Law" by Fechner, and can be represented as follows (*Weber 1846*: *126*):

$$\Delta S \div S = k$$

Weber's law is the hypothesis that with a given sensory faculty, the just noticeable difference in stimulus variation ΔS and the starting stimulus S sit at a constant ratio to each other k. So if we consider the example that was mentioned for Fechner's just noticeable difference, ΔS is the minimum change in freezer temperature that will elicit a report in experienced temperature change, S is the initial temperature of the freezer, and k is the constant ratio between the two that remains true across *all* such instances of me putting you in my freezer starting at any temperature, and indeed across all such qualitative experiments regarding reported temperature change.

Weber's claim is that each sensory modality has a different fixed k constant: a k inferred through experiments with reporting temperature change would be different to one yielded through experiments regarding sensitivity of light perception for instance. However, Weber's law was later criticised by Fechner who refuted its prevalence across the senses, proving through experiments that the law in fact only holds true approximately for some senses while not being present at all when considering others- Weber's law fails in its accuracy concerning perception of loudness across lower volumes, for instance (*Fechner 1860: Chapter 9).* Fechner used Weber's formula to develop his own:

$$I = k \ logS \div S_0$$

Fechner's law states that the degree of a given sensation to a specific individual is proportional to the logarithm of the stimulus intensity: take the example that I am speaking to you at a fixed distance from across a library, whispering at 30 decibels, speaking to you at 60 decibels, and then bellowing to you at 90 decibels. Fechner's law states that your experience of loudness does not vary linearly with the stimulus in the way that Weber's law states, but rather a logarithmic relationship dictates that the difference in experience of loudness between 30 and 60 decibels might feel to have a larger difference in intensity than that from 60 to 90 decibels, and so on.

Weber and Fechner's laws have both been criticised for their ability to only demonstrate homomorphisms between a limited scope of given sensory magnitudes and their stimuli, however they do still provide robust evidence that in certain instances mental properties appear to operate in ways that are predictable according to fixed quantifiable laws. William James provides a critique to their methods of particular relevance:

> To introspection, our feeling of pink is surely not a portion of our feeling of scarlet; nor does the light of an electric arc seem to contain that of a tallow-candle in itself... if we were to arrange the various possible degrees of the quality in a scale of serial increase, the *distance*, *interval,* or *difference* between the stronger and the weaker specimen before us would seem as great as that between the weaker one and the beginning of the scale. It is these RELATIONS, these DISTANCES, which we are measuring and not the composition of the qualities themselves, as Fechner thinks (*James 1890: 546)*

James's quote here leads us to two important points regarding Weber and Fechner's early psychophysics. Firstly, James discredits Fechner's conception of the character of the measurements he yields through psychophysics, insofar as only information about relations are yielded rather than measurements of sensory magnitudes themselves. While this notion might fly in the face of Fechner's philosophy of measurement at the time, it sits entirely coherent with the stance of fixed point realism arrived at in the previous chapter: in particular instances where Fechner and Weber's laws hold true for a given sense, we can demonstrably yield information about the structure of a particular mental property and how it relates to others across the same sensory modality, *if* we are to consider the detachment of using physical measurements to yield measurements of mental properties via proxy a non-issue; this idea will be returned to at the end of the chapter.

Secondly, though James makes mention of pink and scarlet as though they sit on the same measurement scale as two different magnitudes of "redness", we are introduced to a sensory modality where the same linearised treatment workable with mental properties such as brightness/loudness does not appear to be possible concerning perception of colour as a whole, as we'll discuss shortly. It is here where we must consider the efforts of scholars who have attempted to assess the measurability of mental properties that are not so easily represented in a simple linear fashion, to determine whether or not measurability of mental properties is found only with sensory modalities that can exhibit such linearly represented magnitudes.

Section 3: Measurement of Colour

If the realm of subjective experience were composed solely of properties that can be described linearly in a way similar to experienced loudness and brightness, then there might be a great deal less difficulty in utilising measurement to map out the relational features of mental experience. The problem of direct measurability seems to be more of a concern when considering mental properties that don't exhibit a sense of linearity, made apparent when we consider the relationship between physical proxies and the different types of mental property that we might be trying to indirectly represent. With linear mental properties such as experienced brightness or loudness, their corresponding physical proxies exhibit a linear mathematical structure fit for representation in a metric space and can be subjected to robust mathematical treatment, allowing these measurements yielded via psychophysics to tell us something about the structural relations of these properties.

In the absence of linear structure it would appear that if there exists physical proxies usable for the measurement of nonlinear mental properties, they would require more elaborate treatment to translate into meaningful measurements than those utilised for yielding measurements of linear mental properties. To explore this idea, we should consider the efforts made by scholars concerning the measurement of colour experience as a nonlinear mental property, before considering what this tells us about the strengths and limitations we face when attempting to measure mental properties using psychophysics.

Something important becomes apparent considering the measurement of experienced colour relative to ideas discussed previously: the forms of measurement scale discussed in the first chapter, and indeed most types of representation employed in conventional measurement practices, involve the ordering of magnitudes across a single-line scale, however this is a mode of measurement representation that doesn't prove applicable to colour experience as a nonlinear property. We can return to the work of Hermann von Helmholtz, who performed a series of experiments whereby he isolates two rays of different coloured light, with either ray being subject to change in both colour and quantity via apparatus (*Helmholtz 1866: 139-40)*. Both rays of light are focused onto a completely white surface, and by adjusting the colour and quantity of either beam, he can determine which two beams of light are each other's complement, insofar as when combined against a white surface the pair "neutralise" and produce a white light.

Helmholtz used these experiments to determine which hues of colour are more intense in relation to their complements: a greater quantity of yellow-green light is paired with a complement beam of violet light of lesser quantity for instance, thus Hemholtz would say that the colour violet is of greater intensity than the yellow-green colour. Helmholtz used findings from such experiments to construct his representation of colour space*:*

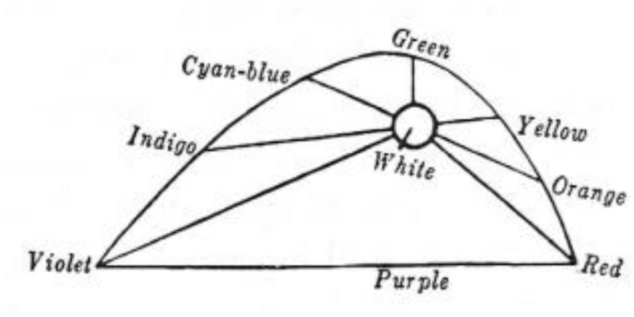

Figure 1: Helmholtz's colour space (*Helmholtz 1866: 139)*

In Helmholtz's mapping, the further a colour is from the white region the greater its intensity or saturation, with rays of light from colours further from the white region having complements that are closer to the white region (with the less intense complement countering with greater quantity). Hemholtz has appeared to succeed in producing a geometrical space wherein colour as a nonlinear property can be represented in a meaningful manner, that being the dimensions of colour defined by relations of visible intensity. However, we should return to the point in the previous section regarding the significance of using physical proxies as a means to yield measurements about mental properties, in this instance using Helmholtz's light ray experiments to yield information about the structural relation of colour experience in the human mind.

Alistair Isaac makes a critical point against the ability of Helmholtz's colour space to represent measurements of colour as an experienced mental property (*Isaac 2013: 17-8)*. Helmholtz uses the quantity of light as a physical proxy for perceived brightness- if there is not a direct linear relationship between these two properties, then Helmholtz's colour space doesn't actually tell us anything about the structural relations that exist across experienced colour at all, and as it would happen we can find nothing of Helmholtz's metric space as well as this proxy-reliant methodology that offer relevant descriptive ability. If we consider the distances between the colours mapped out in Helmholtz's metric space, they don't seem to correlate much with the psychological distances between colours as we would know of them through experience: greater distances exist through the mapped points of purple, violet and indigo than blue, green and yellow, with the latter set being mapped with less distance apart despite containing a range of colours that we experience as a far more variant span of hues than those in the first set.

Helmholtz falls short in providing a framework that can suitably utilise a physical proxy to produce measurements that can mirror the structural relations between colour as a non-linear mental property. With the complexity of the situation demonstrated, we can consider the work of W. D. Wright, who performed experiments regarding the measurement of perception of colour using a concept and methodology similar to Fechner's just noticeable difference. Wright used an updated colour space not entirely unlike that formulated by Helmholtz, insofar as the distances in its metric space aren't analogous to the differences across instances of colour perception:

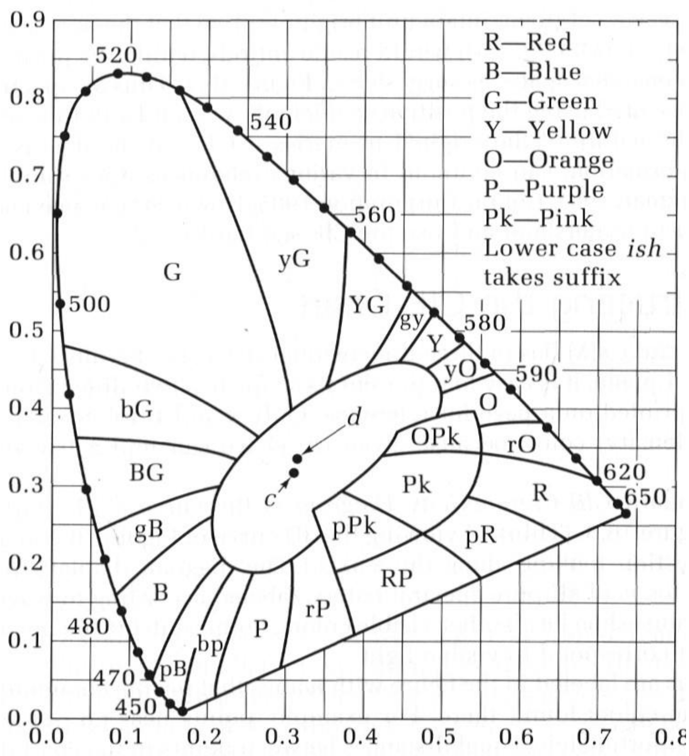

Figure 2: A construction of the CIE 1931 colour space (Benjamin 1998)

A significant development in representing measurements of colour experience that Wright presents regards his use of methodology in accordance with this CIE colour space, employing a process of noticeable differences not unlike the work done by Fechner (*Wright 1941: 94-9*). Wright's experiments utilise a test subject sitting opposite a white screen split in half by a divider, with two separate beams of light being cast on respective halves of the white screen. At the start of the experiments both beams are set to the same wavelength of colour, before the test subject is told to slowly adjust a dial that alters the wavelength of one of the beams. The subject announces when they detect a noticeable difference, at which point the deviation from the initial wavelength of colour is recorded, and then after a reset the subject does the same while adjusting the dial in the opposite direction- this entire process is repeated 3 times for sake of reliability. From this experiment, data such as the following recorded by Wright can be displayed over his CIE colour space:

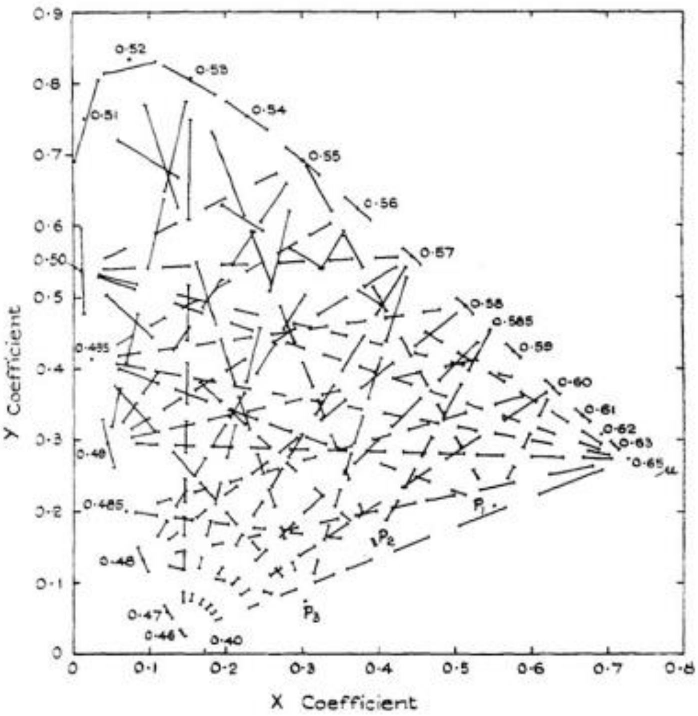

Figure 3: Results obtained from perceived colour change experiments (Wright 1941: 99)

Here we can see meaningful representation of perceived differences in colour across a spectrum: the length of each line indicates the difference between two fixed wavelengths of colour required to elicit a perceived change in colour. Wright's findings displayed in Figure 3 demonstrate that through experiments such as his we can identify the partial asymmetry between physical and mental colour properties, while still highlighting that they bear a degree of structural relation to each other, and to speak to the reliability of his methods, Wright's mapping of differences in colour perception across his CIE colour space remain fairly consistent not only across his repeated experiments with other subjects, but also with other theorist's similar experiments (*Isaac 2011: 25-7).*

What does this mean concerning the question of the measurability of colour as an experienced property? Through methods such as Wright's we are able to discern and describe structural relations between given instances of colour experience, using physical colour as both a proxy to yield measurements as well as a means to construct a metric space where the measurements of colour perception can be represented and compared meaningfully. In terms of relating this to the question as to whether non-linearly presenting sensory modalities can be considered objects of measurement, we can see through Wright that experience of colour presents itself as one such sensory modality that can be subjected to valid measurement practice that fulfils the criteria for Fixed Point Realism as outlined in the previous chapter; the necessary involvement of physical proxies to yield such measurements is not insignificant however, and is a discussion that will be raised at the end of the chapter.

Through meticulous means Wright has been able to associate measurability and a degree of quantifiable character to subjective instances of colour, in terms of how experiences of colour relate to each other structurally, and it is Wright's work and the example of colour that serves to clarify both the specific strengths and the apparent limitations that measurement as an investigative procedure has when directed to matters of the mind. Measurement has a peerless capacity to describe to us a particular world of structural properties, while non-relational features of mental properties, i.e qualia or *what-it-is-likeness* of subjective experience, are not features we are able to discover with a degree of objectivity via measurement practice. Measurement of mental properties requires the involvement of psychophysical methods as we have seen, which allow us to directly associate structural features of experience with their physical proxies and brings these structural aspects of experience into a realm of objectivity. Having discovered the role psychophysics has when concerning measurement of the mind and the relationships found between mental property and physical proxy, we should now consider a more difficult to measure mental property that is featured very heavily in other areas of philosophy.

Section 4: Measurement of Pleasure

A focus of many historically prominent ethical theories has been to provide a framework to assess the moral value of an action or outcome in accordance with some assessment of pleasure or pain, either in an individual or across a population (*Bentham 1789*; *Mill 1861*). Ethical theories of these types treat pleasure as a property that has a definite value, one that might be taken to be inserted into a theoretical framework and used as a determining factor for evaluating the morality of a given action or outcome. Casual value judgements of whether or not a given action is going to yield more pleasure guides our decision making constantly and seems to form a fundamental component of the human existence; if pleasure is truly measurable, then judgements of pleasure can go beyond subjective decision making and form the basis for accurate interpersonal comparisons between the pleasure of given experiences.

One basis for regarding pleasure as a measurable property is outlined by W.D Ross, who reasons that through our lives we are constantly having experiences that are pleasurable to precisely varying degrees, and that there exists between two different experiences a continuum of potential experiences that occupy the varying degrees of pleasure in between (*Ross 1930: 142-3)*. Ross writes how if two pleasures are sufficiently comparable and recent in memory, then we can easily make definitive assertions about whether or not one is greater than the other: the moment I kissed the girl I'd fallen in love with was decidedly more pleasurable than the few moments later I stepped on some lego, for instance, and what this reveals is a definite quantitative quality to the pleasurability of our experiences. In instances where two pleasures cannot so easily be compared, Ross argues that the failure lies in the experiencing person's capacity for making such an assessment between pleasures given limiting conditions rather than some pleasures themselves simply lacking quantitative character completely.

Is this argument that Ross makes more plausible than the notion that some pleasures cannot be treated as possessing a comparable quantifiable character? Hastings Rashdall puts forward a simple example of some real world quantities that are strictly quantifiable but to which human judgement is unable to compare with any precision, describing an instance whereby a person is made to compare at a glance two similarly sized piles of sand (*Rashdall 1899: 376).* The analogy serves to reinforce Ross's argument: the pile-glancer is without the means to derive a precise relation of quantity through the limitations of his mode of inquiry rather than the sand heaps themselves not possessing a definitive grain-count. Some attempts to yield comparisons between pleasures might find themselves failing on similar enquiry-bound limitations, so we can reason that when two pleasures don't appear fit for mental comparison that this might not be through virtue of the pleasures not possessing a precise quantifiable value.

We can identify a few obvious limitations of mere introspection as a mode of such enquiry, one being that comparing pleasures often relies on memory. The ecstatic night I won my first squash-growing competition might've been embellished in memory and recounted over and over such that I can make no accurate comparison to how much more pleasurable it was than my wedding night that I'm currently experiencing. In other instances a pleasurable experience might find itself so intense or attention demanding that it makes a value judgement with any degree of precision at the least very difficult- in these circumstances we can see examples of the limiting conditions that Ross would describe. Taken to its most generous conclusion, Ross's argument would endorse the perspective that it is restricting subjective conditions such as these that make quantifiable comparison between different pleasurable experiences seem implausible, and that the range of possible pleasurable experiences all share a comparable underlying property.

The case for pleasure as a measurable mental property consistently comparable across a comprehensive range of experiential contexts is one that needs heavily defending, however. The Problem of Heterogeneity is a classic objection to cases made regarding pleasure as a quantity (*Hall 1966: 38*; *Ross 1930: 142)*, speaking to the circumstances in which it seems unintelligible to consider two pleasurable experiences as having comparable quantities and where it is not immediately obvious that easily explainable limitations of the senses are at fault. Consider comparing the pleasure I experience when reading from front to back my favourite book *The Guinness Book of World Records 1991* over a Friday night with the more immediate pleasure of eating a chocolate liqueur, one that brings me intense momentary euphoria- concerning this pair of pleasures, there are two important issues of heterogeneity that we need to discuss. The first matter of heterogeneity that we must consider concerns the intensity and duration of the two pleasures: across the night of reading my book, I might maintain a fairly consistent level of moderate enjoyment over several hours, whereas when I eat my chocolate liqueur, I experience a gripping ecstasy that far exceeds any moment of my book reading but one only experienced for a tiny fraction of the time. An obstacle arises when we consider how these two pleasures might be compared: can I definitively say that one pleasure as a whole is greater than the other, taking into account the varying durations?

To overcome the first issue there must be a way in which we can divide or aggregate durations and instances of pleasure in a meaningful way, in a manner similar to some conventional derived measurements. John Hall offers a description of how such might be achieved, providing in detail an example that details the theoretical conditions required to yield such a standardised unit of pleasure (*Hall 1966 : 44-51).* In his example, Hall describes a boy who has a taste for bull's eye sweets, consistent such that between the hours of 8am-8pm, he eats one every hour with a level of pleasure identical in each instance of eating- from this we can yield a standard unit of pleasure, that being equivalent to how much pleasure the boy experiences during the eating of each bull's eye. Hall describes how if the boy were totally rational in his decision making, we can demonstrate that measurements of pleasure can be yielded from this standard of bull's eyes: perhaps the boy would trade no more than two bull's eye sweets for a go on the swing, for instance, or would trade precisely twelve bull's eye sweets to borrow his sister's gameboy for a day; intensity and duration is accounted for. Hall's example demonstrates the theoretical conditions under which we could construct a seemingly robust measurement framework for pleasure- if a method of measuring pleasures similar to that described by Hall is possible, then this first issue of heterogeneity can be accounted for.

Justin Klockseim raises an important issue that can be levelled towards Hall's example (*Klockseim 2009: 185-9)*. As has been discussed previously, the human mind is far from infallible when reflecting upon experiences that have already passed, and indeed even regarding matters of present experience it seems an impossible claim to say that I could evaluate *exactly* how much I enjoy eating bull's eye sweets in relation to the full range of experiences I might be made to compare to. I could make an estimate through memories of my experiences of eating bull's eyes and then to the best of my evaluative abilities relate that to other activities wholly dependent on my imagination, however the example Hall describes is a situation where the boy has some kind of privileged access to the precise value of his enjoyment of bull's eye sweets. Even if Hall is just describing the boy's level of evaluative ability as hypothetical conditions for his argument, this very condition itself presupposes that pleasures exist as precise quantities, and so by begging the question the argument fails to account for this first issue of heterogeneity.

The second issue of heterogeneity is one made obvious when we consider how different two distinct pleasurable experiences can be. Fred Feldman provides the example of a man lying on the beach being subjected to two different pleasurable sensations: the feeling of warmth under the sun and the pleasant smell of the salty breeze- aside from the fact that both of these experiences are pleasurable, there is very little in common between the two that would yield them fit for comparison (*Feldman 1988: 83)*. At its most potent, we could take this second issue of heterogeneity to imply that there is no shared quality intrinsic to the wide range of different experiences that we would describe as pleasurable at all, and while it might be the case that we could find a way to precisely quantify two sensations of a sufficiently similar type, vastly different pairs may not be amenable to such treatment. We could consider the intellectual satisfaction from having finished a very interesting book very difficult to compare to the pleasure of receiving a good massage, as they are phenomenologically completely different in their appearances, even if we have a similar favourable attitude towards either experience as being fairly pleasurable.

Relevant to this second issue of heterogeneity are the ideas raised earlier in the chapter concerning psychophysics, and we can see how compared to the measurement of experienced colour, the measurement of experienced pleasure is a far more convoluted endeavour from a psychophysical perspective. Consider the relationship between wavelength of visible light as the physical proxy to experienced colour: a (comparatively) straightforward model of understanding is employed, where wavelength is varied different stimulus is provided to the eye, which corresponds to changes in our experience of colour- a psychophysical perspective gives us a plausible description of colour that can be attributed to a single phenomenon and regarded as a single measurable property, where two different experiences of colour can be associated with measurements via psychophysics and compared in the same metric space using wavelength of visible light as a valid physical proxy. The specific asymmetrical relationship in structure between colour experience and physical colour varies across individuals of course, where my colourblind father's colour experience of driving through a red light in oncoming traffic would be completely different to my experience driving through the same red light. Nonetheless, given sufficient experiments for each individual, psychophysics would make clear such specific structural correspondences, and I would be able to relate a measured wavelength of red light to what I'd expect my father to experience given that I'd already mapped out how his range of colour experience varies in accordance with physical colour.

It is not so obvious that we can find such a closely associated correlate for pleasure as a single measurable property however, where the psychophysical circumstances under which different pleasurable experiences can occur can be entirely different. Consider Feldman's example of enjoying both the feeling of the warmth of the sun as well as the smell of the salty breeze: these sensations are associated with two completely different psychophysical phenomena, the former with a favourable stimulation of the thermoreceptors on the beach man's skin, and the latter with a favourable stimulation of the chemoreceptors in the beach man's nose. I might conduct a range of psychophysical experiments similar to those employed for colour experience using just noticeable difference to discern the temperature ranges that are most pleasurable for the beach man- we could construct a plausible metric for beach man's "pleasure from temperature" as a single property, but psychophysics only appears to reinforce the second issue of heterogeneity and fails to provide any reason to attribute the two different types of experience as having a shared measurable "pleasure" property with shared associated psychophysical phenomena.

With the problem of direct measurability a seemingly inescapable reality that any efforts to measure mental properties must navigate, measurement of mental properties as far as can be conceived currently seem heavily predicated on the use of appropriate physical proxies. To return to the concerns raised at the start of the chapter, this reliance in itself shouldn't be considered a reason to discredit the validity of measurements of mental properties yielded in this manner; physical measurements are constantly faced with bridging the epistemic gap between experience and the physical- for instance if I were to weigh my briefcase of pennies on a digital scale, I would have an experience of seeing a number on the display and would take the value displayed to be indicative of the physical forces external to my experience that I would understand to be the weight of my briefcase. That the inverse in the form of a reliance on physical proxies should be a problem for the validity of measurement of mental properties does not seem to be the case, and the successes surrounding the measurement of experience of colour serves as perfect testament.

This success is not so obviously shared with the measurement of pleasure. The two issues of heterogeneity raised make it difficult to conceive that the range of pleasurable experiences that we are able to experience share an underlying mental property fit for structural comparison, and on a practical level the inability to identify a common psychophysical correlate as we can for experience of colour makes imagining a measurement procedure fit for quantifying pleasure a critical issue. Modern neuroscience does suggest that a range of different types of pleasurable experiences can be associated with many overlapping areas of brain activity (*Berridge and Kringelbach 2015: 5)*, and perhaps it could be that one day we will have better modes of analysis that can compare some suitably overlapping neurological phenomena with corresponding pleasurable experiences. Nonetheless, there is a multiplicity involved when we are concerning ourselves with a group of many different psychophysical phenomena, only most or some of which may share in correlating with two different pleasurable experiences, and so these phenomena do not lend so easily to treatment as a single physical proxy in the same sense we would with wavelength of visible light.

Of the features of experience that we can conceive of as measurable mental properties i.e loudness, brightness, and colour, it may be the case that pleasure as a singular property is simply not one of them. Raymond Tallis speaks of the "de-experiencing" that measurement entails, wherein objects that we direct measurement to are essentially stripped down to their simplest of quantifiable properties (*Tallis 2018: 123-4)*- here Tallis speaks regarding physical measurements, but the point is particularly relevant to us regarding mental properties. In the case of measurement of loudness and brightness which we can conceive of as linear properties, this stripping down to quantities doesn't diminish the feature of the experience that we are attempting to articulate via measurement. Concerning attempts to measure pleasure as a single property, this stripping away of features to reveal an underlying property is not possible because features essential to the pleasure itself are disregarded in the process: a pleasurable experience is fundamentally qualia and *what-it-is–like*ness, and though we might be able to make non-arbitrary value comparisons between pleasurable experiences, this does not admit to the existence of a common underlying measurable property, in the same sense that I might argue firmly that the loudness of my morning foghorn is more intense than the brightness of my dim bedside candle. With the strengths and limitations of measurement as an investigative procedure directed towards the mind made clear, we can now proceed to consider what bearing this has on the relationship between the mind and sense-separate reality.

Measurement and the Mind-Body Problem

Section 1: Introduction

In the three chapters previous we have considered the ability measurement has as an investigative procedure, the way in which we can attribute a level of realism to the structural relationships that measurement presents to us, as well as the limited successes and inherent difficulties involved with measurement when directed towards the properties of the human mind. Measurement appears to be a tool altogether more suited to discerning features about a mind-separate physical reality rather than the subjective mind and the structure of experience, and this presents to us an apparent dichotomy between physical properties and mental properties. These ideas explored via measurement have a great bearing on an existing area of debate in philosophy known as the Mind-Body problem, a sphere of discussion that concerns the reconciliation of the existence of both physical and mental features in reality.

In this chapter we will explore some of the stances raised towards the mind-body problem in light of the ideas that measurement raises, assessing three distinctive stances: Functionalist Physicalism, Panpsychism, and a Kantian inspired Idealism. Different perspectives held towards the Mind-Body problem would regard the types of potentially measurable properties we've discussed in previous chapters, whether they be physical or mental, in different manners- some stances might seek to explain how it is that mental and physical features coexist and interact in a dualistic reality, while others may seek to reduce or explain how it is that we exist in a reality that is populated by only one type of property or the other. The dichotomy between the types of property that measurement presents to us is of great significance concerning the limits of human enquiry as we currently know it, and through exploring some of these positions concerning the mind-body problem, we will see how we can better understand the relationship our experiencing selves have with the properties that we measure, and what this might tell us about the type of reality that we find ourselves experiencing.

Section 2: Physicalism and the Inverted Spectrum

Some issues central to the mind-body problem become obvious when we assume a simple dualistic stance towards reality, taking the stance that the things that exist in our reality are either distinctly physical or distinctly mental; problems arise when we consider how it is that two completely different areas of reality can have any level of interaction at all. Various problems of interaction have been levelled towards a dualist standpoint, one of which concerns the completeness of physics, an issue presented on the grounds that the descriptions our inquiries reveal to us about physical reality present it very much as causally closed- David Papineau summarises: “All physical effects are determined or have their chances determined by prior physical [causes] according to physical law” (*Papineau 1993: 16).* Our models for understanding the interaction of the physical world can be plausibly detached from any notion of mental properties entirely, with no intervention of mental property or qualia being required to maintain the efficacy and explanatory power of our theories regarding the interactions of the physical world- crucially this includes the brain and the functioning of intelligent, complex life. This argument for causal closure, as well as the fact that measurements of physical properties provide far richer description and integration into our theories and models for describing reality than mental properties, can inspire reasonable doubt as to whether or not mental properties exist independently at all.

A common approach to adopt concerning this problem of interaction between the physical and the mental would be to reduce our definition of what exists to be fundamentally the physical; what exists in reality could be described as equivalent to that which we understand as physical properties, and we would be able to regard measurement as the process by which we come to discern the fundamental nature of reality, that being one comprised entirely of physical properties. Such a standpoint would assume a stance of Physicalism, several of which regard our reality to be one that is composed entirely of physical matter occupying points in space, and that furthermore to this any features we might consider more complex than base physical materials are features that can be reduced or explained away as simply being emergent from this base physical reality (*Stoljar 2010: p16).* For instance, I might look out my window and be able to describe the massive whirlwind approaching my house as simply an amalgamation of a great many individual physical particles that are subject to a set of behaviour defining laws, not especially different from the area of particles that inhabit and form my physical body as I glance indifferently at the whirlwind outside.

There have been several key physicalist theories that would adopt such a view, an early one of which being U.T Place's Identity Theory (*Place 1956: 44-50).* Place argues that mental properties don't possess existence independent from the underlying physical states they emerge from, such that if I were to exclaim "I get a rush when I watch my pet snails race", I would not be describing a sensation that exists independently in any real sense, rather my statement would be an emergent description of the underlying physical state of my brain that occurs when such an event happens- in this case perhaps a combination of a neurological response to my adrenaline levels and my brain's stimulation from the wavelengths of light from the snails, to give an oversimplification. Place's theory successfully avoids any problem of interaction by taking an entirely reductive stance towards mental properties, however what his ideas seem to leave absent is a sufficient explanation as to what makes brain states special such that we come to associate experiences with them.

David Lewis offers a seemingly plausible explanation for the physicalist, stating:

> The definitive characteristic of any (sort of) experience as such is its causal role, its syndrome of most typical causes and effects. But we materialists believe that these causal roles which belong by analytic necessity to experiences belong in fact to certain physical states. Since these physical states possess the definitive character of experiences, they must be experiences. (*Lewis 1983: 100)*

Here we can see an explanation as to how it is we might come to associate experiences with brain states, with any kind of problem of interaction being avoided because Lewis completely reduces experiences to nothing ontologically distinct from their fundamental physical states. In reductive Physicalist arguments such as those that might be held by Place and Lewis, the apparent issue between physical properties and mental properties can be completely ignored, because in actual fact talking about mental properties is the same as talking about physical properties, since all features of experience can be reduced to the physical.

A major problem that reductive theories such as these become a target of is outlined by Hillary Putnam known as the problem of Multiple Realizability, where he provides his famed example concerning the experience of pain (*Putnam 1967: 37-48)*. Putnam describes how a reductive Physicalist theory would define the experience of pain strictly as a specific brain state, in this instance "C-fibres firing", such that by logical necessity anything we would be able to call an experience of pain *must* be an experience completely identical to a physical state of the exact type "C-fibres firing". Here we can find the problem of Multiple Realizability for the reductive Physicalist, whereby he is forced to explain how it is that a given experience such as pain that presents itself with the same experiential features can be realised under completely different physical conditions. Perhaps when my pet snail painfully fumbles a jump, a type of physical event "F-fibres firing" occurs in his neurons, alongside his experience of pain that is incredibly similar to my experience of pain when my "C-fibres" are firing- for a reductive Physicalist, there is no way to identify such similar or identical experiences as being of the same type.

Terence Horgan offers a more persuasive form of Putnam's reasoning, describing how experiences that we would regard as the same would see themselves subject to Multiple Realisation within the same person across different times and circumstances, given that in the same individual neurobiological phenomenon will change depending on the structure and conditions of the person's brain at different points of life (*Horgan 1993: 308)*. A key point to take from Horgan's reasoning is that a reductive Physicalist is left without the apparatus to describe their own experiences with any persistent or stable definitions, because their experiences are solely defined by instances of particular configurations of physical properties, which themselves are not persistent in their composition. Reductive forms of Physicalism leave us with no useful or intelligible way to identify or discuss subjective experience, which is widely seen as a major problem.

A suitable Physicalist response can be found in Functionalism, which when adopted with a non-reductive Physicalist approach, can provide arguably the strongest case for the Physicalist to date- Michael Antony offers a concise outline of a Functionalist perspective: "Conscious states and processes are conscious rather than not in virtue of their particular causal relations to inputs, outputs, and other mental states and processes." (*Antony 1994: 105).* Following the Functionalist rationale, causal relations and intricacies of computation and function are in actual fact ontologically one and the same as the conscious experiences that we come to associate with them- rather than mental properties actually being identical to the physical states they belong to following reductive Physicalism, instead a given experience simply an entire physical functional state. When I exclaim "I get a rush when I watch my pet snails race", as a Functionalist I would be referring to the sum of the functional state within my brain as a physical arrangement that realises the function I am referring to as an experience. Functionalist Physicalism is seen by some as providing the most persuasive form of Physicalism because it evades a key issue known as Multiple Realizability. Other Physicalist theories such as Identity Theory take a wholly reductive stance regarding experience, a stance where mental properties aren't considered ontologically significant beyond the underlying physical states that they can be reduced to, however Functional states are more abstractly defined and provide a much more stable way to associate mental properties with physical properties- this is how Functionalism evades the problem of Multiple Realizability, a pitfall that other Physicalist theories fail to counter.

When considering measurement, a position of Functionalist Physicalism seems appealing because it avoids the issues regarding mental measurability, where the complexities of experience as they appear to us are merely emergent or functional features given form by fundamental physical properties- problems encountered regarding the measurability of mental properties can be disregarded if we could simply assume that the only properties that exist fundamental to reality are the physical. The apparent dichotomy between the physical and the mental no longer presents itself as problematic because we wouldn't expect mental properties to present themselves to us in the way physical properties do- our reality is conveniently populated strictly by publicly accessible and measurable properties of a stable quantifiable nature, followed secondarily by consciousness and experienced properties which themselves are realised by combination of measurable physical properties, when it just so happens that they form a particular functional role.

However, despite presenting itself as an elegant solution both for measurement theorists who might wish to avoid the problems associated with mental measurement as well as those looking for a non-reductive Physicalist resolution to the Mind-Body problem, Functionalist Physicalism finds itself targeted by highly effective criticism. Of particular interest to us due to its relevance to measurement is a type of Inverted Spectrum argument, an area of reasoning that concerns qualia and the experience of colours. John Locke offers an early line of reasoning that goes on to form the basis of the argument- concerning different experiences of colours between individuals, he wrote: “the Idea, that a Violet produced in one Man's Mind by his Eyes, were the same that a Marigold produced in another Man's, and vice versa [...] this could never be known” (*Locke 1689: 389).*

Locke's point resonates with the Problem of Direct Measurability as discussed in the previous chapter, highlighting the issue that the features of another person’s experiences, be they colour qualia or other mental properties, possess about them a fundamental character that cannot so easily be brought about into the realm of definite consensus. There exists no known inquiry or measurement procedure that can be reached out to ascertain the intrinsic *what it-is-likeness* of another persons experienced representations of colour- indeed concerning the dimensions and relational properties of experienced colour we can make a fairly good sketch via the use of physical proxy, which it seems would provide us with an exhaustive account of the functional features of a given person’s colour vision- leaving qualia seemingly irrelevant and plausibly interchangeable following Functionalist Physicalism.

Numerous forms of the Inverted Spectrum argument have been constructed to articulate a similar notion, many of which describe a situation concerning the inversion or alteration of how one experiences the spectrum of colour. Michael Tye offers a typical demonstration of the argument, describing a situation involving a man Tom who completely unknowingly experiences an inverted spectrum of colour, such that when he looks at a red object he in actual fact has an experience of seeing what to anyone with normal vision would be the colour green, and vice versa (*Tye 1994: 171-2)*. We can elaborate on this example with reference to measurement of colour experience in the previous chapter, and proceed to state that despite representing colours with completely different qualia, the structure of his colour experience is completely homomorphic to that of anyone with non-invert colour experience. Tom is perceptive to differences and similarities between colour to a completely normal extent, and there would be no way to determine through any behavioural experiments that Tom's colour qualia are different from anyone else.

The fatal blow such an Inverted Spectrum argument poses for the Functionalist Physicalist is that we are left with entirely coherent descriptions of scenarios where functionally analogous physical states realise completely different qualia and mental properties. In the expanded example of Tom's experience of colour, his perceptions do not differ in a functional sense from anyone else's, and so the fact that it is in no way contradictory to suppose that the phenomenal contents of Tom's visual experience could be entirely different to a normal person's generates the conclusion that functional states alone do not provide comprehensive means to identify experienced mental properties, and so it would seem difficult to argue that mental properties supervene upon functional states. Ultimately, though a Functionalist position succeeds in avoiding problems faced by other forms of Physicalism, the description of functional states does not provide a satisfactory way to identify experienced mental properties with directly measurable physical properties, regardless of the appealing simplicity to the idea that measurement as we know it can reveal all there is to know to us- namely a reality of solely physical properties. In an effort to identify a solution to the disconnect between experience and precise measurable physical properties that still respects the fundamental character of experience and mental properties, we will have to consider another perspective on the Mind-Body problem.

Section 3: Structural Coherence, Emergence, and Intrinsic Properties

To arrive at a defensible stance that is non-reductive concerning mental properties, we will have to in some manner address the Hard Problem of Consciousness, an issue outlined by David Chalmers (*1995: 5-6)*. Chalmers presents the reasoning that despite experience of subjective consciousness being directly knowable to us, we are very hard pressed to find any obvious explanation for the existence of mental properties and qualia within our theories about the physical world, or even to find support for the existence of phenomenal consciousness at all using methodology grounded within the sciences and physical measurement. The Hard Problem of Consciousness can be seen as a response to issues similar to those that motivate arguments about causal closure, with the charge Chalmers levels instead being to reason why it is that consciousness exists despite its juxtaposition with our best current models about the physical world, rather than excluding consciousness from any definition not fundamental to a causally closed world of physical properties.

Of particular note to us concerning measurement is Chalmers's discussion about structural coherence (*1995: 17-20)*, which forms part of his speculative case against the reduction of experience and mental properties- Chalmers writes "Any information that is consciously experienced will also be cognitively represented. [...] Internal mental images have geometric properties that are represented in processing". Chalmers is discussing the homomorphisms in structure between mental properties and their psychophysical correlates here, which is firmly backed by conclusions arrived at in the previous Chapter. While in many cases it may be anywhere varying from completely impractical to impossible to find a suitably stable measurement procedure to quantify certain mental properties (he mentions emotional intensity, which would be a prime candidate for such issues), an appeal can be made to the features of experience that appear to be distinctly relational to make the claim that much of experience possesses a structural character, even when not feasibly measurable- structural features that mirror those found in physical cognition.

If we follow Chalmers's ideas, we can consider that structural relations are fundamental to the mode of presentation through which conscious experience and individual mental properties appear to us- a notion that is arguably supported by our first-hand intuitions about experience. Without an innate awareness of structural relations between mental properties, much of our interactions in the waking world would make little sense: consider a simplified example where I have invited you around for dinner and raise to your mouth a forkful of pie, then knowingly tell you "Try a bite of this but not yet- it is too hot, and I know you'll be enraged!". Perhaps in the past I have watched you eat a slice of pie of the ideal temperature by my standards, before exclaiming "This is far too hot!" and storming off in a manner presenting behaviour that I would associate with my own experiences of rage- a reaction I myself would never have when eating an overly hot slice of pie. For my use of language to make sense I have to make reference to several types of mental properties that we both share, while also presupposing that they inhabit a specific structural framework.

What this example serves to highlight is that there is an innately known structural nature to the mental properties that populate conscious experience, intuitive to the extent that we formulate beliefs and make assertions that rest on the notion that this underlying structural nature exists intersubjectively, despite mental properties standing relative to different standards between individuals. In Chalmers's terms, the accessibility and reportability we have regarding this relational nature of experience reveals that consciousness mirrors corresponding structures of awareness in the brain, such that physical cognition and consciousness "do not float free of one another but cohere in an intimate way" (*1995: 19*), despite the notion that with the Hard Problem withstanding, facts about physical cognition do not necessarily entail facts about mental properties. Evidence for this structural presentation of experience is consistent with discussion about the measurement of mental properties in the previous Chapter, where the sensory modalities accessible to measurement via physical-proxies demonstrate this pairing. Concerning the mental properties that yet allude effective treatment via measurement, a reasonable argument can be made such that- if we existed in a world where our best current measurement capabilities were not yet able to measure experience of loudness, for example, in relation to a physical-proxy, then we would not take any less for granted that experienced loudness does vary structurally in a linear manner.

This intimate coherence between the mental and the physical sits more soundly from one side of the equation: my experiences share a very close structural resemblance with systems revealed in the measurable physical world, even if these cognitive systems find themselves completely defined by parts of a meticulous but otherwise featureless mapping of fixed points and their structural relations- a picture that leaves no room for the integration of qualia and mental properties. Despite the metaphysical leap of faith required it would be absurd for me to say that this apparent mirroring of structural form is a coincidence and that there isn't some reason behind this appearance of structural coherence in the places we find it so clearly demonstrated. However, problems arise when we try to figure out which physically defined systems find themselves structurally mirrored with consciousness and mental properties- which is where we will consider the first of two particular areas which a non-reductive stance on the mind-body problem is required to address, that being of emergence.

Many, such as Chalmers, believe a perspective wholly grounded in the impressive picture of the world painted by physical measurement leaves us without the apparatus to meaningfully integrate conscious experience- a reason for the failures of the forms of Physicalism that we have already considered. From such perspectives we are left with scenarios such as "philosophical zombies" seeming plausible- scenarios where entirely ordinarily presenting people are interacting and demonstrating their functioning systems of cognition while also being entirely unconscious and lacking in mental properties (*Kirk 1974: 135-9).* It comes as no surprise that this seems tenable from certain Physicalist perspectives because all descriptions for phenomena and interaction are defined within wholly physical systems and causes, zombie or otherwise, whereas a non-reductionist would make one case or another for consciousness to be intimately cohering with the brain in each circumstance in which no zombies are to be found.

The charge for the non-reductionist is to explain what makes particular arrangements of measurable physical properties special, such that they find themselves cohering with conscious experience- my brother is probably not a zombie and has an experience containing mental properties, and I would say the same about his two cats- but what about his pet stick insect? What about his lovingly tended nettle bush, or even his complex AI gardener that is digitally modelled after his own physical brain structure? It does not seem immediately clear where to draw the line, making an acceptance of brute emergence of consciousness, as described and derided by Galen Strawson (*2006: 18),* even more unintelligible- we cannot merely take it for given that consciousness appears to emerge from intelligent, cognitive systems because we still have no way to identify consciousness with one intelligent configuration of physical properties and not another, less complex cognitive system. For a non-reductive stance on the mind-body problem to be deemed acceptable, emergence will have to be suitably accounted for.

To demonstrate the second area that a suitable non-reductive position will have to address we can consider our knowledge of mental properties, and that they consist of both intrinsic and relational features. The intrinsic features to my mental properties consists of qualia, the phenomenal contents of my experience that are inherently inexpressible- what it is like for me to taste butterscotch, for instance, which may in actual fact be identical to your qualia associated with tasting apple. The relational features of my mental properties are defined by how they exhibit structure in the context of my experiential horizons- my experience of tasting butterscotch sits adjacent in some explicit manner to the *what-it-is-likeness* of the qualia I would experience when tasting caramel, for instance, even if my "almost caramel" qualia are in actual fact identical to your "almost pear" qualia . Without any reference to the physical cognitive systems that they cohere with, we can demonstrate that mental properties exhibit conceptually separable intrinsic and relational features, even if we find these features both equally necessary to the mode through which mental properties are presented to us.

We can see further evidence for this conceptually separable relational feature of mental properties when we make comparisons to the world of physical properties, when cognitive systems consisting of measurable physical properties find themselves intimately cohering with respective elements of conscious experience. If I were to conduct a comprehensive study using methods within psychophysics to map out how your experience of loudness as a linear mental property varies, given perfect practice presumably the measurements I could yield would provide an exhaustive account for the relational nature of your experience- there would be nothing about how your experienced loudness varies structurally that my measurements wouldn't appear to articulate. What we can observe here is that the relational features of mental properties can be publicly articulated in a manner that their intrinsic properties cannot, and, in addition, descriptions for relational features of experience can be recognised in the world of measured physical properties- relational features that we know to be inseparable from intrinsic features, at least to the extent that relational features cannot exist without there being intrinsic features to relate.

So, if the properties we are most directly acquainted with necessarily possess both intrinsic and relational features, then what are we to make of our after-the-fact map of measurable physical properties, which themselves only present to us relational features? Firstly, it should be remembered why it is impossible from the starting point of an experiencing subject to know anything other than the structural features of physical properties- we can return to ideas raised by Bas van Fraasen, discussed in Chapter 2, and consider that knowledge of intrinsic properties beyond the senses would require an "impossible God-like view in which nature and theory and measurement practice are all accessed independently of each other" (*Van Fraasen 2008: 139)*. How we are positioned with regards to the world of physical properties is such that it is only through extraordinary effort and the coordination of theory and apparatus that we are able to glean this structural mapping- which is nonetheless an incredible working picture of how the world is beyond the certainty of individual subjective experience. Measurement yields exclusively structural information because with the means our comprehension and best efforts can allow, impressive positioning of tools and use with efficacious theory can only ever yield mathematical, relational results- and that is a reason why direct measurement of the qualia of mental properties is an incoherent proposal.

Of course as we have already discovered the world is more than merely relational properties, a picture that would reduce all things merely to "each other's washing" as Bertrand Russell once said (*1927: 325*), and we are left teased with the possibility that measurable physical properties are in actual fact properties with a known measurable structural quality *as well as* an unknown (in physical terms) intrinsic quality, a feature not accessible to measurement or other modes of inquiry, only direct introspection or self-awareness. To find a non-reductive position on the mind-body problem that makes sense, we must explain why it is that conscious experience appears to emerge from certain configurations of physical properties without having to concede to brute emergence, while also suitably reconciling the picture of intrinsic and relational features of properties that our inquiries leave us with, to make some sense of the relationship between subjective experience and the properties that populate reality. The non-reductionist is committed to the notion that mental properties have an existence not merely defined by the relational features measurement presents to us, and so we are left with the question as to whether physical properties also possess an intrinsic nature, and if so, what, if anything, can be deduced from them.

Section 4: A Panpsychist Response

In searching for a defensible non-reductionist stance towards consciousness, we should consider the idea that the world of external relational properties that measurement reveals is actually a world of properties that possess an intrinsic conscious nature, a nature in some ways similar to the qualia of our own private experiences. Such a view would be one of Panpsychism, which defined broadly is the notion that conscious experience is a feature found in all natural properties (*Bruntrup and Jaskolla 2017: 365)*, rather than being specifically associated with cognitive organisms. A stance of Panpsychism could provide a promising response to the concerns the non-reductionist faces regarding emergence: for the Panpsychist consciousness is totally ubiquitous, and so there is no longer a special feature about the brain as a sum of relational properties that finds itself uniquely implicated with the emergence of consciousness. Following this general stance of Panpsychism, all properties possess an intrinsic, conscious nature, eliminating any inexplicable special feature of brain matter that grants it some privileged status of existing hand-in-hand with conscious experience.

Important for us to consider is the strong draws a view of Panpsychism can have in relation to the problems and ideas discussed relating to measurement. Gustav Fechner, whose contributions to the field of psychophysics were discussed in Chapter 3, was a known advocate for a Panpsychist perspective regarding the properties that populate reality- he wrote regarding the ubiquitous nature of consciousness:

> Is this totality a single being which appears only to itself, a being which can just as little be recognised by telescopes, earthdrills, yardsticks, chemical reagents, all the mathematics in the world as the corresponding being in us can be viewed with microscopes, scalpels, chemical analyses, and mathematics? (*Fechner 1861: 10)*

Arguably, there exists no other area of human inquiry where the apparent two-facedness of the world in terms of its differing relational and intrinsic natures is more evident as with measurement in psychophysics, where the structural coherence between experience and measurable physical properties can be found so explicitly. Fechner was made keenly aware of the inability for measurement to articulate information beyond the mathematical features of experience, and sees this observation as providing reason to believe that the external world glimpsed only as structure when measured also possesses its own intrinsic experienced features, beyond the grasp of measurement.

The notion that the picture of the world as a sum field of interacting physical structural properties is incomplete and that these properties also each individually possess an intrinsic nature follows ideas raised within Russellian Monism (*Alter and Nagasawa 2012: 70-2)*. Not every form of Russellian Monism endorses Panpsychism, but when considering measurement, integrating this Russellian notion that properties are both relational and intrinsic in their nature with a theory of Panpsychism provides as much explanatory convenience as a reductionist solution to the problems associated with the measurability of mental properties, because it follows that physical measurement already *is* a direct description of experience- the structural nature of the mental is directly measurable to us in the form of physical properties as they appear to us, which from this Panpsychist perspective are in actual fact one and the same as the knowable relational features of experience. In other words, physical properties as they have been discussed previously can instead be understood to the Panpsychist as the measurable element of physical properties- properties with measurable *and* intrinsically experienced features. A Panpsychist stance influenced by Russellian Monism seems to remove any need to explain the emergence of consciousness from the solely structural picture that measurement presents us with, while also demystifying the special presentation of both intrinsic and relational features within subjective experience, which is no longer unique to the domain.

Despite the apparent conveniences this interpretation of reality offers, Panpsychism faces numerous problems that are difficult to account for. We can consider that the elegance of a Panpsychist response to the mind-body problem comes from the fact that consciousness is no longer any special feature to account for at all- even the most basic constituents of physical reality such as quarks are conscious for the Panpsychist, albeit in an manner incredibly simple to the point of being totally unrecognisable to our own experience (*Goff 2019: 112-4)*. However, this apparent ubiquity of consciousness throughout the physical world presents more questions- why do we find ourselves having a unified experience that is supposedly formed of many individually conscious physical properties, and on what grounds do we find the features of this unified consciousness defined by these smaller, also conscious parts? These are concerns that are raised in various forms of the "Combination Problem" originally traceable back to William James *([1890] 1981: 160)*, which present challenges often seen as difficult for a stance of Panpsychism to overcome.

One particular form of the Combination problem faced by the Panpsychist when attempting to explain the combination of smaller conscious properties is that of "subject summing" as outlined by Sam Coleman (*2014: 25-7)*. Following our

Russellian stance of Panpsychism, subjectivity is an intrinsic component to the physical properties that populate reality; experience involves a phenomenal point of view to be experienced- any conceivable sense of conscious *what-it-is-like*ness is had within the private field of a subject, irrespective of how simple that consciousness might be, and so the Panpsychist must concede that so as with consciousness, individual instances of subjectivity are also ubiquitous and found for every independent conscious property. Following this idea, Sam Coleman raises an issue for the Panpsychist, suggesting that the notion that a sum of subjects can aggregate themselves in some manner to form a distinct and unified new "greater" subject is entirely incoherent. Subjectivity is by definition the isolation of experience, and so for some dissolution of boundaries between subjects to allow otherwise privately contained basic experiences of properties to be subsumed into a greater subject, we have to somehow justify the destruction of the fundamentally isolated, private character of subjective experience for each subsumed experiencing property. Supposing that these experiencing properties do somehow escape the confines of individual subjects to form experience in a greater subject, we are now left with a problem very similar to standard emergence: what makes these particular arrangements of measurable experienced properties special, such that they forsake the confines of individual subjectivity to be subsumed into a larger subject?

Panpsychism presents itself as an elegant non-reductive solution to the mind-body problem that is able to make sense of nature's two-facedness, but in actual fact this attempt at a simple explanation inherits difficulties very similar to those found with Physicalism. We can return to the notion of Philosophical Zombies, a concept which can be repurposed to highlight problems regarding a Panpsychist interpretation of reality (*Goff 2009: 297-302)*. Panpsychist Zombies can be conceived of in numerous ways: let's say that my physically identical anxious twin in actual fact possesses no subject summing conscious experience, but instead only the independently existing physical properties that inhabit his brain and nervous system have experiences- and perhaps my other anxious twin has a unified sum of subjects that amounts strictly to the isolated bodily sensation of being terrified, while simultaneously having another separate sum of subjects that amounts strictly to the visual experience of being on a rollercoaster. The problem is, there is no reason to believe that both twins aren't entirely possible following Panpsychism; any powers of explanation are firmly grounded within the realm of measurable relational features, to which the theory owes its false impression of convenience.

A Panpsychist account that we owe conscious experience to the intrinsic, experienced quality of properties that are otherwise measurable and understandable in physical terms unfortunately provides an unsatisfactory explanation. We can consider the idea that these properties that possess both relational and experienced qualities would have to contain within them all the explanation for the rich and varying qualia that we find presented to us in unified conscious experience. Howard Robinson puts forward the analogy of a painter being only able to paint strokes found within the infinite spectrum of black-to-grey-to-white provided he only has access to black and white paints to make a comparison to the most basic constituents of reality (*Lockwood 1993: 275-8)*. The Panpsychist who is committed to the fact that any measurable basic constituents of reality (quarks for instance) possess an intrinsic experiential character- an experiential character that is entirely responsible for the varying richness of experience and all is qualia- must concede that these measurable properties, whether we find them in the brain or left alone in space, contain within them sufficient description for the more complex experiences they give rise to when they are combined. The problem with attributing the complexities of consciousness to measurable properties of the physical world is that they present themselves as wholly interchangeable- why should one collection of the same types of basic physical constituents form the particular qualia associated with my subjective experience of pain, while another different mass of the same types of basic physical constituents form my subjective experience of pleasure?

Those looking to explain away these problems with Panpsychism may adopt an alternate perspective known as Cosmopsychism, a view that considers that the features of our conscious experiences are actually grounded in facts about a higher level macro consciousness- the universe itself as a whole entity (*Shani 2015: 408-14).* The solutions offered by such a view seem appealing- we no longer have to try to explain the rich appearances of qualia using facts about individual basic properties in a manner that seems indeterminable, because we derive the complex appearances of consciousness from a source of even more complex experiential features- features as equally unknowable to us as the intrinsic experience of a quark would be to a regular Panpsychist, just entirely on the other end of the scale in terms of richness and complexity. Cosmopsychism also disarms the threats associated with forms of the Combination Problem because we are no longer having to wrestle with the supposed combination of basic forms of consciousness to form our own, because instead *we* are regarded as a more basic form of consciousness in the order of explanation while we point outwards to this greater, universal sum of phenomenal properties that we supposedly inherit from.

However, Cosmopsychism faces a problem only slightly different in the form of "derivation" *(Nagasawa and Wager 2017: 121-3)*, which concerns the issue of how and why our instances of known consciousness inherit themselves from this greater cosmic source of phenomenal properties. If consciousness is ubiquitous but instead now in this unified universal sense, in what circumstances are less complex, individual consciousnesses present, and under what laws do they derive particular phenomenal content? Unfortunately, Cosmopsychism only offers respite from our conventional Panpsychist's problems by putting more features and laws of interaction beyond the reach of explanation. Adam Pautz presents this view, arguing that Cosmopsychism involves a "huge, endless swarm of big-to-small grounding laws" (*Pautz 2015: 45-6)* that completely denies the initial motivation for an argument of Panpsychism, that being its explanatory simplicity. While Cosmopsychism shouldn't be ruled out with complete certainty, the supposed relationship of inheritance between known consciousness and the universe as a single source of phenomenality leaves even more gaps of explanation than had by regular Panpsychism, since at least the explanatory task of the latter is to explain consciousness through combination of known measurable properties.

While Cosmopsychism presents itself with little positive explanatory value, Panpsychism as a whole also seems to have failed us at providing a link between the measurable physical world and the world of subjective experience. Beyond the similarities in structural appearance that we can see displayed through psychophysics, there seems to be nothing else we could reasonably find within measurable, physically defined properties that could explain the rich and diverse appearances of experience. Ultimately any stance of Panpsychism that offers a solution to the mind-body problem can only do so while explaining problems associated with emergence and combination- problems that cannot be resolved if the Panpsychist concedes that the constituents of reality are also fundamentally relational properties. Perhaps in an attempt to find a more satisfying non-reductionist approach, we should consider the possibility that the difficulties presented to us when reconciling the view of the world as measured relational properties with the world as known through subjective experience is a result of a false mereological assumption.

Section 5: Horizons and Transcendental Reality

Perhaps we need to revise our perspective regarding the mind and its relationship with the objects and physical properties that populate reality- a "horizonal" conception of experience, as first described by J. J. Valberg (*1992: 120-152)*, certainly provides an important shift of understanding. We can consider the idea that when discussing our experiences, one way we can understand them is in a phenomenal mode, the standard and largely unquestioned approach in the philosophy of mind and psychology, concerning ourselves with how our experiences feel as a sum of properties that are felt as phenomena. For example, in a given moment I might define my experience in terms of the qualia I am experiencing, mental properties of tasting butterscotch accompanying others of hearing a dinner bell, for instance. When thinking of experience in this mode, I am attributing to the phenomenal appearances I am presented with a subjective character- private properties that might or might not be telling me something about the objective world. Barring a stance like panpsychism, from this phenomenal mode of understanding, it would sound plausible that if I were the last experiencing being left in existence, then my phenomena would be the *only* properties in reality with this subjective feature, in a world populated otherwise solely by measurable physical properties, which I may or may not become aware of through mental properties when I direct my experience towards them. The crucial point that will be explained shortly is that following this phenomenal mode of regarding experience, my worldview is split between subjective mental properties, and objective properties that my subjective mental properties might be correctly informing me of.

On the other hand, to think of experience in a horizonal mode as outlined by Valberg, we have to put aside the idea of experience as a sum of phenomenal properties, to consider what it is that experience of the world entails. Valberg uses reflection on thought experiments involving dreams to isolate some defining features of experience when conceived of in this horizonal mode, extracting features common to experiencing the "real" world other conscious subjects find themselves also experiencing, as well as experiencing the hypothetical world of a dream (*2007: 82)*. When experiencing a dream, it would be a confused prospect for me to identify the properties in this dream-world and then make a similar division between subjective properties and non-subjective properties, after the fact of falsely assessing my dream surroundings and misidentifying external features of the objective world. It would be confused because there is no objective dream-world, of course. The feature of subjectivity is not necessarily something to be assigned to particular properties that I might come to regard in experience, rather it is something I assign after the fact of experiencing the world, whether real or in a dream. In the waking world, a prior condition to me regarding particular features as being subjective is that reality appears to me at all- that reality exists *in,* or *within,* an experienced horizon. A horizon is the experiential context in which I find myself centred to experience reality, a context that can only be described in the sense that it makes the particular contents of my experience possible. On the horizonal conception, then, consciousness is not what appears to me, but the horizon within which things appear to me, where these "things" might be phenomenal experiences or physical objects. The prior fact of me experiencing the world ensures that the world exists within my particular experiential horizon, and so if we reconsider the phenomenal mode of regarding experience that attributes certain properties of the world as possessing a feature of "subjectivity" and not others, following the horizonal mode of understanding experience I would in actual fact be attempting to place a feature within my conception of reality that isn't *within* my reality of properties at all- it is part of the way in which reality exists in every sense within my horizon. A phenomenal experience is phenomenal not for its possession of subjectivity, a special property, but because it appears in a horizon in a certain way, one which is different from the appearance of a physical object.

We can get a better understanding of this horizonal conception of experience with reference to ideas presented by James Tartaglia, who relates Valberg's horizons with the notion of transcendence (*2020: 75-81)*. We can use an example similar to what Tartaglia uses to describe a given horizon of consciousness- in waking life, this horizon will contain within it a part of the objective world: the large sewer carp I might see and smell after a long day of fishing would be directly experienced within your horizon of consciousness as well if you were to join me on my fishing expedition, for instance. If while celebrating my catch I were to eat a patch of fungus before falling unconscious and experiencing a dream trance, my experience would not contain anything of the objective world- the hallucinations within my horizon would not be of any objects or features that would be found in your waking horizon, nor would we expect this to be the case. In the case of my dream trance, my experience is merely of subjective appearance, even if I hallucinate that I am actually still stood perfectly upright fishing in the sewers- in this instance, my experiences are transcended by the objective world where I am actually unconscious, and while I lie in this trance, my experiential horizon can *never* actually contain anything of the spatiotemporal contents of the objective world around my body, even if an identical hallucination is presented to me. When I wake, my experiences are no longer transcended by the objective world, which now exists within my conscious horizon; subjective images of my surroundings tell me of my own sensory relationship with the world but also inform me of the objective world, which is part of a greater reality that transcends my own subjective sensory context and relationship with the objective world- a greater reality that also contains the subjective horizon of my pet bat who would come to know the same parts of the objective world in very different experiential terms, for instance.

The crucial point here is that when regarding our experiences in the phenomenal mode, we are forcing two different conceptions of reality- that of subjective mental properties, and other non-subjective properties that these subjective mental properties are telling us about. But when we conceive of experiences in the horizonal mode, we would do no such thing; I would not pick out and describe particular features of subjectivity within my horizon, because the horizon is simply the experiential context for the world appearing to me- subjectivity is not something to be ascribed to things I find within my experience, rather it can only be conceived of as a condition for the world to exist within my experiential horizon in the first place. So, it could be thought, following the ideas presented by Valberg and Tartaglia, that the issues contained within the mind-body problem are in actual fact due attempts to force descriptions of subjectivity into a world knowable only to us in the terms of an objective world that appears within experiential horizons- understanding of the true nature of which ultimately transcends understanding being, that it concerns the experiential context within which we have experiences and formulate our understanding of the world in the first place.

Tartaglia says of experiential horizons conception of experience: “It is that part of ultimate reality which each of us can individually infer from the fact that we experience a world [...] A horizon limits both experience and thought, thereby setting up a context of existence in which all our understanding is moulded to fit what we can experience, and leaving only the undeniable fact of existence when we try to go beyond that context” (*2020: 80)*. Let's say my experience of the world in a horizon includes the jar of pennies sat in between me and the aforementioned alien, for me with the same qualitative features that the object always is found with given the same conditions- a particular shade of brown when under the bright lights of the bank, for instance. These qualitative features cannot be explained using the modes of thought I have access to within my horizon- unlike the structural nature of this same sensory modality, which can be gleaned through measurement. What we could say then, is that the qualitative features of my experiences (which I might have ascribed the feature of "subjectivity" following the phenomenal mode) are part of the way reality appears in my horizon, the true nature of which ultimately *transcends* my ability to understand them, beyond the structural world they reveal. We might assume that a similar regularity extends to the experience in the horizon of the alien banker- such that he always has experience of "sonar qualia X" when experiencing the jar of pennies in particular sensory conditions- ultimately, the qualia of his experience transcends my capacity for precise understanding as well, being a part of the greater context in which he experiences the same reality that I do. What we do find however, is a world of structural properties that are fairly indiscriminate to our sensory modalities (such that we can both infer the same physical properties through our different horizons of the world) which can be understood structurally, to an incredibly precise manner, as the history of measurement has clearly revealed.

Valberg's horizonal conception of experience alongside Tartaglia's minimal description of transcendent reality can make sense of inexplicabilities that present themselves when we otherwise attempt to insert both subjective and objective features into our understanding of the objective world. Consider the juxtaposition between the *nowness* of experience (*Paul 2010: 344)*, and reality otherwise understood in an objective manner. Following a phenomenal mode of thinking, I might be tempted to go along similar lines as with subjectivity and force my experience with its special kind of *nowness* into the same picture of the world populated by the objective properties that my experiences make me presently aware of, despite the fact that interrogation of the physical world reveals evidence of no such privileged "now" (*Rovelli 2018: Chapter 13)*. If we return to the horizonal mode of regarding experience however, we can consider that this feature of *now* is not really a feature to be described independently at all, rather it is a fact of existence within a horizon- to attempt to describe something that isn't *now*, is to describe something that doesn't exist within a horizon.

So, why should this approach to the mind-body problem be accepted? If we employ Valberg's ideas about horizons and Tartaglia's outline of transcendence, we can talk about the limits of human comprehension in a meaningful way, and can make some sense of why we are presented with difficulties like the hard problem of consciousness, emergence, and the intrinsic properties found exclusively within our own experiences- namely, because when we encounter these problems, we are attempting to conceive of the non-structural features of experience using the only framework of understanding we have access to within our experiential horizons, that being concerning strictly objective, relational properties. While we are made aware of non-relational features that our experiences have, whether the complex appearances of qualia or the *nowness* of my experience, we can only know of them in the limited manner that they facilitate existence of the world within an experiential horizon- to understand these features, I would have to somehow completely transcend the mode through which I experience and understand the world- an ultimate dissolution of experiential context, which by very nature is something that could not be known nor experienced.

The response to the mind-body problem this offers succeeds in not reducing the reality of experience, while also making sense of the fact that the incredibly detailed picture of the world that measurement provides us with can offer no power of description with regards to the non-structural features of experience. If we consider the common sense belief that my horizon is not the only one that exists, and that reality has many experiencing beings of the world all with different sensory relationships with the same objects that I could also experience, then we are referring to features that, if they exist, entirely transcend my capacity for understanding (other minds, alien qualia etc) that other responses to the mind-body cannot make any room for in their explanatory apparatus, because they are limited to certain explanatory means- those being of the external, relational world, which we can conceive of as being the only mode of understanding accessible within experienced horizons. Where then does this leave measurement in our understanding? We can reconsider from Chapter 2 one of Allistair Isaac's criteria for regarding measurement of a property as demonstrating its likely reality as a fixed-point, that being convergence- the notion that the same relational property can be accessed by different modes of measurement, which is part of the justification for our belief that it exists in the real world. Upon reflection, what can be measured might articulate the *only* knowable parts of the world that exist objectively - the common structural features of objects, reduced to their most defining and basic relational explanations, that are indiscriminate to the varying sensory relationships we might have to same world of objects that we both experience in different horizons.

The supposed dichotomy between mental properties and physical properties is put to rest if we accept this understanding, because measurement can only entail the description of relational properties- the qualitative content of experience is not something that can be understood using the ways we have of making detailed sense about the world we experience, hence the two-faced appearance of psychophysics where we are left trying to re-insert experience conceived of as phenomena into the structural framework that we in actual fact extrapolate from experience itself in the first place. Measurements articulate the only commonality to the experience me and my alien banker would have of the same object that can be brought into objective reasoning- essentially the *point of contact* for our experiences in a reality in the sense where we share the same world of objects at least partly defined by their relational properties, despite other features of our differing qualitative realities as well as the greater context of reality they in some manner are contained within, ultimately transcending our understanding.

Conclusion

Measurement, as a mode of inquiry, can provide an incredibly specialised way of understanding the word we find ourselves experiencing. In the ancient world, great thinkers recognised certain regularities about the world presented in experience; regularites that can be articulated through the language of relation, and descriptions of mathematics. Through regarding its history, we can discover how measurement has provided for us a changing description for the world as knowable in terms of its relational features, a description of magnitudes and the objects they belong to that provides a very particular trustworthy and accurate account. Euclid, the "father of geometry," established the concept of magnitudes and the ratios that can be described between them. As a mode of inquiry, measurement is embedded into human understanding of mathematics and the sciences. There is an important distinction between fundamental and derived magnitudes, fundamental magnitudes being features in reality that closely mirror fundamental principles of mathematics. Given that different measurement theorists have contrasting viewpoints, we can arrive at a general definition of measurement that allows for difference of perspective, while still maintaining the unique capacity measurement has in articulating how certain properties in reality relate to one another. We can arrive at the general definition for measurement: an objective description of a property that is invariant in rational discourse, that allows us to express facts and conventions about properties in a symbolic language. This definition emphasises the intersubjectivity of the information that credible measurement procedures can yield, and articulates the special capacity measurement practices can have to represent particular properties in reality as factual.

Having defined measurement as a mode of inquiry in a broad sense, we can consider the important question of realism: how can we justify the belief that measurements are capable of describing properties that exist independently of our experience or measurement procedures? Many of us hold this belief as part of our common-sense understanding of measurement, and it is also accepted subconsciously within much of the scientific community. However, there are various issues that challenge the realist stance and support an anti-realist case against measurement realism, which include the problem of theory-ladenness, underdetermination, and the fact that different measurements can give conflicting results. A stance of "Operationalism" offers a very poor alternative to a stance of realism, because it offers no criteria for the accuracy for measurements and also requires an exhaustive definition for each measurement operation, making it entirely impractical. Measurement procedures cannot exist without reference to theory, and this holistic context of theory and measurement is circular, presenting issues such as "The Problem of Theory Change'' and the "Contrastive Underdetermination Argument" that a stance for realism about measurement is required to respond to. "Semantic Instrumentalism", which concerns the problem of how to bridge the gap between a yielded measurement and the external property it is trying to articulate, and "Conventionalism", a theory that describes the character of measurement as one defined strictly by conventions dictated via pragmatic concerns, articulate more features that go hand-in-hand with the theory dependence of measurement. To provide an adequate response, we must appeal to a form of "Structural Realism" , which provides a convincing account that measurement can tell us about the world of relational properties invariant to surrounding theory, which may well change. Ultimately, the most plausible account for measurement realism exists in the form of Allistair Isaac's "Fixed-Point Realism", which provides measurement with criteria for success while avoiding an over dependence on the changing theoretical contexts that measurements find themselves inhabiting. Measurement represents one of the most incredible epistemic achievements of human thought, despite the fact that the contexts for understanding these structural features of reality changes with our ever-developing theories about the kind of reality we find ourselves in.

Following this understanding of how we can say that measurement describes to us properties in reality independent of the mind, we can then turn the efforts of measurement inwards, and consider the prospects of measuring features in the mind itself, which presents a notoriously difficult area. The challenges found associated with measuring mental properties concern that of direct measurability-properties in the physical world can be encountered and understood in a very direct manner, whereas measurement of mental properties requires the engagement of psychophysics, a field that uses physical measurements to indirectly yield measurements of mental properties. Principles of psychophysics can be linked back to the works of Gustav Fechner and Ernst Weber, who identified the relationships and laws found when observing mental properties and relevant physical stimuli. Psychophysics can demonstrate a degree of quantifiability about mental properties through identification of the visible structural mirroring between mental experience and given physical proxies. Mental properties that can be described linearly, such as experienced loudness and brightness, lend themselves very well to treatment as measurable properties with the use of psychophysics, but we can find an even more structurally complex domain of human experience that can be found amenable to measurement using psychophysics, that being experience of colour. While the intrinsic appearance of colour in terms of qualia is something that measurement cannot articulate, measurement can reveal the structural arrangement of human colour experience. Conceiving of experience of pleasure as a singular mental property reveals difficulties and limitations with regards to measurement, and it might be the case that the structural arrangement of the world that can be gleaned from measurement only extends so far. Dependence on physical proxies presents a necessarily limiting factor for attempts to measure the contents of subjective experience, and it seems there are features of our experience that *seem* quantifiable, but evade the reach of description that measurement can offer.

Finally, given sufficient understanding of measurement as an investigative procedure, as well as the fundamental limitations measurement has with regards to describing the structural nature of human experience, we can consider the greater context within which reality presents itself, a reality that presents itself as being populated by directly measurable physical properties, alongside mental properties that are less amenable to description using measurement. Adopting a stance of "Physicalism", which is the dominant metaphysical worldview of the current day, presents many issues; if we are to understand reality as being fundamentally physical, i.e what essentially exists is *just* physical properties that can be known and measured, then it becomes impossible to account for human experience. Qualia and the intrinsic features of human experience cannot be accounted for using purely Physicalist descriptions of reality, and attempts to describe *why* it is that consciousness emerges from seemingly unconscious physical properties is something that perspectives within Physicalism ultimately fail to explain. Panpsychism attempts to offer a non-reductive solution by conceding that *all* matter possesses an intrinsically conscious feature; unfortunately, this perspective inherits similar explanatory burdens to Physicalism, and fails to account for the "Combination Problem", where it seems equally difficult to provide a link between the measurable physical world and complex subjective experience. A compelling change of perspective is offered by Valberg's "Horizonal" conception of reality and human experience, wherein features of subjectivity are not reinserted into descriptions of reality because there is simply no way to experience reality without this fundamental subjective feature. Tartaglia expands on this idea in relation to "Transcendence", where we can find an incredibly compelling and plausible explanation for why it is we cannot make sense of the true nature of our experiences: such an understanding would necessarily transcend the experiences themselves, and it is not possible to comprehend the true context in which we have experience of the objective world inside subjective experience.

This horizonal conception of human experience alongside the idea that ultimate reality necessarily transcends human comprehension makes sense of the differing presentation between mental properties and the physical properties we encounter in our experiences. The apparent inexplicabilities between the detailed structural mapping of reality as made known in the form of measurements and the intrinsic nature of subjective experience is no longer a source for confusion following this understanding, unlike the incomplete explanations offered by other stances of the mind-body problem. The incredible epistemic capacity measurement as an investigative procedure possesses should be held in incredibly high regard, and we can acknowledge that directing measurement efforts inwards and seeking to quantify mental properties is something that will only ever be able to yield structural descriptions, which is sure to be equivalent to physical descriptions of the brain. Developments in neuroscience will provide increasingly detailed accounts for the brain when understood in terms of this structure, and we may well be able to describe more and more intimate structural coherences within the human mind when understood as a sum of its objective, relational features. The horizonal transcendent perspective on reality can provide more reason to consider measurement of mental properties as a valid pursuit, because the brain is no longer confusedly being conceived of as a physical phenomena that exists independently of subjective experience.

The measurable brain is the outwards appearance the mind presents to the world, and so mental properties actually *are* being measured in a direct manner when we use measurements to describe the brain- following the horizonal transcendent perspective towards the mind-body problem, this is the only manner in which it makes sense to describe measurement of mental properties. What this leaves us with is a validated conception of mental measurement- where experienced pleasure for instance (if somehow able to be described with some degree of unity under a blanket group of physical brain phenomena), is an entirely plausible object of measurement, because the world of measurable physical phenomena in the brain are one and the same as the structural description of our experiences. This leaves measurement in a very interesting place indeed, where measurement of mental properties is no more indirect than measurement of temperature, for instance- suddenly the cold, relational worldview that Physicalism offers reveals itself as a misinterpretation that *all* there is to reality is relational properties, when that is evidently not the case. Measurements of the physical world are ultimately descriptions of a world we can only know in the sense that they appear to us in experience. This offers a description of reality present in all its richness and meaning, forever behind the curtain of a world only knowable to us as measurable relational properties.

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