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Empirical Evidence and the Multiple Realization of Mental Kinds

Danny Booth
The University of Western Ontario

Supervisor
Viger, Christopher David
The University of Western Ontario

Graduate Program in Philosophy

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Abstract

This thesis explores the use of the concept 'realization' in the philosophy of mind. The primary focus is on the role realization plays in assessing or opposing identity theory. The history of the use of the concept of realization in the philosophy of mind is reviewed, and from that a set of desiderata to be used for assessing accounts of realization is extracted. The desiderata are applied to a sample account of realization proposed by Sydney Shoemaker (2007). Next the application of 'realization' in contemporary contexts is considered, focusing on the idea that mental kinds are, potentially, multiply realized. Based on interpretations of results from research in the relevant sciences this thesis considers two kinds of strategies used to object to multiple realization, (1) arguments against the concept of multiple realization: the Grain Argument (Bechtel and Mundale 1999), and Shapiro's Dilemma (Shapiro 2000), and (2) defeaters for alleged cases/examples of multiple realization proposed by Lawrence Shapiro and Thomas Polger: unification, individual differences, kind splitting, and abstraction and idealization (Polger and Shapiro 2016). The thesis argues that, ultimately, these arguments hinge on the claim that there is no empirical evidence of multiply realized mental kinds. In response to this claim, the fourth chapter presents novel examples of multiple realization drawn from research in the cognitive neuroscience of language. There are three aspects from the study of language that are presented as examples of multiple realization: (1) language lateralization, (2) reading acquisition, and (3) second/multi- language learning. The analysis of these case studies applies Shoemaker's account of realization as a framework for describing the empirical data as cases of multiple realization. Objections to, and defeaters for, these cases are considered and rejected. The thesis concludes by raising the possibility that mental kinds are realized by mechanisms. This proposal involves drawing connections between traditional questions/views from the philosophy of mind with a current research program from the philosophy of science; the view is particularly important in the philosophy of neuroscience and the philosophy of biology, known as 'new mechanism'.

Keywords

Philosophy of mind, philosophy of neuroscience, philosophy of psychology, realization, multiple realization, identity theory, functionalism, mechanisms, new mechanism, natural kinds.

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1. Introduction

My dissertation focuses on developing and defending an understanding of the role of realization and multiple realization in contemporary accounts of the mental. In particular, I focus on the role that empirical evidence from neuroscience and cognitive science plays in assessing accounts of the mind. My aim is to present an empirically informed discussion of multiple realization, focusing on the discovery of cases of multiple realization in neuroscience and cognitive science. Following some stage setting, where I outline the history of the debate between identity theory and functionalism, I advance three desiderata for an account of realization. The desiderata are based on the way that the term was introduced into the philosophy of mind and the use to which the term has been put since its introduction.

The three chapters explore the role realization plays in contemporary views of the mental in the philosophy of mind. In chapter 2, I begin by reviewing an account of realization, the account advanced by Sydney Shoemaker (2007), that meets the desiderata I develop in the introduction. In chapter 3, I present some contemporary objections to multiple realization and reply to those arguments. In the fourth chapter I present examples of multiple realization drawn from current research in the cognitive neuroscience of language.

1. 1. Historical background

One of the persistent goals in the philosophy of mind has been to naturalize the mind. A main objective to further that aim is seeking a solution to the mind-body problem. However, distinctions between the mind and the body have been seriously undermined, most recently by research in embodied cognition, (e.g., Lakoff and Johnson 1999; Clark 1999, 2006; Anderson, 2003; Shapiro 2011; Critchley and Harrison 2013) and enactivism (Varela, Thompson, and Rosch 1991; Thompson 2007). Research characterizing the fundamental and intimate connection between cognition and our bodies undermines the intuition that the mind and the body are ontologically distinct, and as such contributes to

naturalizing the mind. However, the question of what relation holds between the mind and the body remains even if one is convinced that our bodies shape, constrain, or ground our mental lives in various ways.

In my dissertation I explore a prominent answer to the question of how the body and mind are related; the mind is realized by the body. 'Realization', as it is used in the philosophy of mind, is a term of art. It was introduced in a specific philosophical context as a way of expressing a particular philosophical position. Hilary Putnam used realization in contrast with identity when he advanced an early version of machine state functionalism (Putnam 1960). Yet, when it was introduced it was not given a precise definition. Rather, realization appeared as a way of expressing a connection between the mental and the physical that is less restrictive or weaker than identity. 'Realization' was most prominently used as part of an objection to identity theory in the argument from multiple realization (e.g., Putnam 1975; Block and Fodor 1972; Fodor 1974).

Functionalism has been taken as the default position in the philosophy of mind for nearly forty years. One of the reasons for functionalism's success is the argument from multiple realization against identity theory. Briefly, the argument from multiple realization is that mental kinds and physical kinds (typically brain or neural kinds) cannot be identical because mental kinds are multiply realizable. What it means for a mental kind to be multiply realizable is that there are diverse physical systems that could each suffice (non-causally) for the presence or occurrence of a particular mental kind. Examples of space aliens, sentient robots, or other cases drawn from fanciful science fiction are presented to illustrate the possibility that beings who are radically different from us physically could nevertheless entertain the same thoughts and emotions we do. If physically diverse creatures can all instantiate the same mental kinds, then the mental kinds are not identical to any specific physical system or structure. That is to say, there are various ways of implementing the same mental kind, so mental kinds are multiply realizable.

The argument from multiple realization has been extended to argue that mental kinds are explanatorily independent of their physical realizers, and so the sciences that study mental kinds can proceed independently from the sciences that study the physical

systems that realize some instances of mental kinds (Fodor 1974). According to this line of reasoning, the details about the physical facts don't matter for the study of psychological or mental kinds. Resistance to the view that the study of mental kinds is independent from the study of their physical realizers has resulted in some authors questioning whether mental kinds are actually multiply realized. For example, William Bechtel and Jennifer Mundale (1999) use the success of neuroscience in studying mental kinds to suggest that the argument from multiple realization is misguided. Rather than appeal to thought experiments or imaginative examples of fictional creatures that could share our mental kinds, objectors to multiple realization have argued that empirically discovered evidence from the sciences that study the brain are more relevant (e.g., Bickle 2003; Polger 2004; Shapiro 2004). So, there is a shift in the type of evidence used to argue for or against multiple realization, from conceivability arguments to presentations of empirical case studies.

Since its introduction as a term in the philosophy of mind in connection with functionalism, realization is often taken to be the default relation between the mental and the physical. Increased attention to realization goes hand in hand with the popularity of functionalism. But, as critics have rightly pointed out (Shapiro 2004[1]; Polger 2004; Shapiro and Polger 2012) a more detailed account of realization is owed. In response to this criticism more attention has been paid to realization as a metaphysical relation of interest in its own right (rather than simply as an alternative to identity), and some detailed accounts of realization have been advanced (e.g., Melnyk, 2003; Shoemaker, 2007; Gillett 2002, 2003). Since it is only recently that there have been distinct alternative accounts of realization to choose from, there has been even less said about what reasons there are for recommending or preferring one account to another. To remedy this, in the introduction I outline several desiderata any account of realization should meet. As proof that the desiderata are not too restrictive or demanding, I argue in Chapter 2 that there is at least one account that meets the desiderata, the account of realization advanced by

[1] Shapiro comments that, "Another source of difficulty for the project I pursue in this book is the uncharacteristic casual way in which philosophers have presented and discussed the multiple realizability thesis. . . . [L]ittle attention gets paid to what, in the first place, constitutes different realizations of a single functional kind." (Shapiro, 2004, xiii)

Sydney Shoemaker (2007).

In the introduction I review some of the history of the debate between functionalism and identity theory. To understand what realization is, as a relation that holds between mental kinds and physical kinds, it is helpful to understand to what realization is meant to be an alternative. By giving some context to the use of the term 'realization', I develop some conditions on what a successful account of realization should achieve given the history of the use of the term. This review also provides motivation for why one should think that empirical evidence is relevant in deciding whether mental kinds are multiply realized (or realizable).

The remainder of this introductory chapter is split into three major sections. First, I present the desiderata for an account of realization. Second, I address some objections to the desiderata. I conclude with outlines of each of the three major chapters of the dissertation. The first section, dealing with the desiderata, is subdivided into three sections that present the three desiderata and the historical grounding for them. The second section contains two objections to the desiderata, the first by Kevin Morris and the second by Tuomas Pernu. I conclude the introduction with outlines for the three major chapters in the dissertation. The second chapter presents Sydney Shoemaker's account of realization as an example of an account of realization that meets the desiderata. The third chapter reviews arguments against multiple realization based on empirical evidence from the mind and brain sciences. The fouth chapter responds to the arguments against multiple realization by presenting examples of multiple realization drawn from the mind and brain sciences studying language.

1. 2. Desiderata for an account of realization

The desiderata I propose are:

1. The realization relation should support physicalism;
2. Whether a mental kind is multiply realized should be decided on empirical grounds;
3. The account of realization should avoid the causal exclusion problem.

The three desiderata I propose are motivated by the history of the use of the term 'realization' in the philosophy of mind. In this section I ground the desiderata I defend in

the history of the use of the concept of realization.

The desiderata I endorse are similar to considerations regarding realization raised by, for example, Robert Wilson and Carl Craver (2007) or Umut Baysan (2015). Wilson and Craver advance three desiderata to characterize the use to which philosophers of mind put the notion of realization,

> They would like a view of realization that:
>
> - elucidates the relationship between functionalism, physicalism, and reductionism
> - enables us to at least clarify what mental causation and multiple realizability involve (if not tell us whether they occur in the domain of cognition)
> - points the way to an explanation of how organized networks of neurons give rise to the full range of mental phenomena. (Wilson and Craver 2007, 83)

These conditions raise concerns regarding mental causation and multiple realization, as do my second and third desiderata, though mine do so in a more general manner than those advanced by Wilson and Craver. My first desideratum connects an account of realization to physicalism in a more direct manner than Wilson and Craver's first desideratum does. The major difference between the list of desiderata I defend and that offered by Wilson and Craver lies in the third desideratum advanced by Wilson and Craver. My account acknowledges the importance of empirical findings that could be of use in explaining the mental phenomena Wilson and Craver's account emphasizes. In addition, my third desideratum deals with an objection to realization that Wilson and Craver do not raise directly. Their third desideratum assumes that neural kinds play a role in explaining mental phenomena, which entails a commitment to physicalism that I explicitly advance in my first desideratum. However, these are not major differences and the general aims presented by Wilson and Craver align with my position.

Baysan advocates for a pluralist approach to thinking about realization (2015). He defends the position that there are many different ways that 'realization' is used, and different accounts of realization may serve one use of the term, but not another. In discussing its use in the metaphysics of mind Baysan notes that there are two prominent demands on an account of realization,

> So, a non-reductive physicalist's theory of realization should be able to explain, or at least should provide the resources to explain, (1) how a

> property is metaphysical[ly] necessitated by its realizer, and (2) how a property is not causally excluded by its realizer. (Baysan 2015, 253)

These claims can be interpreted as advancing two desiderata for an account of realization, though Baysan himself defends a pluralist viewpoint whereby two distinct accounts of realization could each independently address one desideratum or the other. Before looking at the conditions he advances, it should be noted that Baysan assumes that an account of realization is in service of physicalism. This assumption reflects the first desideratum I advance. In taking the two conditions as desiderata, the second condition closely resembles the third desideratum I advance. An account of realization should not render a realized property causally superfluous. Baysan's first condition bears some similarities to the third desideratum proposed by Wilson and Craver, though it is put in a more general manner than the specific concern Wilson and Craver raise with respect to mental phenomena having neural realizers. The first two desiderata I defend reflect elements of these considerations. My first desideratum requires an account of realization to support physicalism. This means that an account of realization should, in some way, make it clear how physical properties (and the entities that are bearers of those properties) realize mental properties.

In the upcoming three subsections I present the rationale for each of the desiderata I propose. I begin by explaining why realization should be tied to physicalism. Next, I discuss the relationship between realization and multiple realization. Finally, I present a quick review of the causal exclusion argument and explain why it is important for an account of realization to avoid it.

1. 2. 1. Identity theory

To naturalize the mind, there must be an explanation for how mental kinds can have an impact on the physical world. How do mental states and events interact with physical states and events? Identity theory offers one of the most straightforward answers to the question. Identity theory's solution is to suppose that mental kinds just are physical kinds; then the question of how they are able to interact is trivially answerable: mental kinds causally influence the physical world because physical kinds causally influence the

physical world. However, this question presents a prima facie challenge to any view that assigns different ontological statuses to the mental and the physical. In addition to solving the causal interaction problem, identity theory was appealing when it was first proposed because it meshed well with the scientific investigation of the brain that was taking place around the same time.[2]

Identity theory filled a gap left when behaviourism was generally rejected as implausible. Behaviourism denies that appeals to mental kinds have explanatory value; on the contrary, identity theory was proposed specifically as an account of *conscious* mental processes, such as 'being in pain'. Identity theory proposes that whenever a human being experiences pain, a part of their nervous system is active, the so-called C-fibres. The claim is then made that mental state type 'pain' is identical to the activity of C-fibres in a human body. This kind of identity claim is called 'type identity theory' because it identifies a type of mental process, pain, with a type of physical process, firing C-fibers.[3] J. C. C. Smart provides a clear articulation of the core of this view,

> It is not the thesis that, for example, “after-image” or “ache” means the same as “brain process of sort X” (where “X” is replaced by a description of a certain sort of brain process). It is that, in so far as “after-image” or “ache” is a report of a process, it is a report of a process that *happens to be* a brain process. ... All [identity theory] claims is that in so far as a sensation statement is a report of something, that something is in fact a brain process. Sensations are nothing over and above brain processes. (Smart, 1959, 144-145)

Smart's description of identity theory advances an ontological position where a mental kind is present only when a particular brain process is present. The quote above points to an important insight that helped to establish the legitimacy of identity theories; the sense of mental process terms and the sense of brain process descriptions can differ, but so long as their referent is the same, identity theories remain viable. Place contends that we should consider the “is” in the phrase 'a mental state *is* a brain process' as the “is” of composition (Place, 1956, 45). This leaves room for the meanings of mental kind terms

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[2] For example, D. O. Hebb, *The Organization of Behavior:A Neuropsychological Theory* (1949) and Wilder Penfield and Herbert Jasper, *Epilepsy and the Functional Anatomy of the Human Brain* (1954).

[3] Early proponents of this kind of identity theory include J. C. C. Smart (1959), U.T. Place (1956), and Herbert Feigl (1967).

and the meanings of the descriptions of brain processes to diverge, but the event, process, or material in the world that the terms are supposed to pick out is the same. So, the "is" of composition that identity theory uses relates the mental to the physical by specifying that mental states are made out of the physical states with which they are identified. Mental processes and brain processes may differ in their senses which allows identity theorists to explain why our introspective experiences of conscious mental processes differs from the knowledge, or lack thereof, we have about the brain processes of which they are composed.

Identity theory linked itself to the scientific advances made in studying the brain and at the same time provided a way of explaining why sensations (and the language used to describe them) appear to differ from the physical processes that constitute the experience. Identity theory was appealing because it appeared to be allied with the best science of the times about the brain. In this manner identity theory has an advantage over dualism. It is grounded in the physical entities studied by the physical sciences. Identity theory claimed to be able to explain psychological facts by appealing only to physiological, biological, or physical facts. According to the identity theorist, nothing more than descriptions of physical features of the brain is required to explain the operation of the mind; to be taken as a serious competitor with identity theory, an account of the mind would have to be compatible with physicalism in a comparable manner to identity theory.

1. 2. 1. 1. Realization and physicalism

The goal of naturalizing the mind requires us to situate mental kinds in the physical world. This involves explaining how mental kinds exercise causal powers. Identity theory collapses a distinction between mental and physical kinds by defending the that position that each mental kind is identical to a physical (presumably neural) kind. If mental kinds are identical to physical kinds, then the reason that mental kinds are causally efficacious is because the physical kinds to which they are identical are causally efficacious. Mental kind terms and physical kind terms differ in their senses, but the terms refer to the same entities in the world, and so the causal powers of mental kinds just are the causal powers

of the physical kinds with which they are identified. Identity theory is a thoroughly physicalist account of the mental.

Commitment to the causal closure of the physical, the explanatory power of physical sciences, and a preference for a conservative ontology, each provide some reason to accept the importance of physicalism. Identity theory satisfies those goals, and so gives a physicalist what they want. To compete with identity theory, it would be helpful to an alternative account if it could make an equal claim to fulfilling the positive aspects of physicalism. Functionalism is one such alternative. Functionalism is a full-fledged account of the metaphysical nature of mental kinds. My dissertation focuses on the nature of realization and how to assess an account of realization. Insofar as my aim is to propose a way of assessing an account of realization, I set to the side the question of what the nature of the mental is. However, since there is such a tight connection between functionalism and realization, I offer a summary of functionalism in contrast with identity theory.

Functionalism refers to a cluster of similar views regarding the nature of mental kinds. Functionalism takes its name from the idea that mental kinds can be given functional descriptions, and that those functional descriptions are individuative of the mental kinds. It is a view by which mental kinds are identified on the basis of the relational or functional role(s) that a mental kind plays within a system. The kinds of functional descriptions taken to be individuative of mental kinds can be about the causal features of those kinds, their computational roles, or based on psychological theories about cognitive roles. Functional descriptions of mental kinds are abstract descriptions of roles within a system of inputs and outputs.

In principle a functional kind can be realized by anything that is capable of occupying the specified role within the relevant system. As such it is possible that more than one physical kind could occupy the same functional role in a system. Moreover, there is nothing that inherently precludes a functional role from being occupied by non-physical kinds, so long as a relevant non-physical kind can play the functional role in question. In other words, functionalism is in principle compatible with dualism. This is not necessarily a welcome result. For functionalism to count itself as a physicalist account

of the mind, something more must be said. This is where realization plays an important role in articulating functionalism. A version of physicalism can be stated in terms of realization, such as: a kind is acceptable to physicalism if it is a physical kind, or if it is realized by physical kinds. Examples of this method of presenting physicalism come from Andrew Melnyk (2003) and Sydney Shoemaker (2007). Melnyk advances an account of physicalism based on his account of realization (2003). Shoemaker (2007) also presents an account of realization that, when taken together with his view of physical kinds as causal kinds, provides another account of physicalism based on realization. Functionalism together with a relevant account of realization gives functionalism a physicalist grounding. Stating that a kind is physical if it is either a physical kind or realized by physical kinds, of course, leaves it open what counts as a physical kind, but insofar as it is applied to mental kinds, it makes it clear why mental kinds could be counted among a physicalist's ontology if mental kinds are realized by physical kinds.

Functionalism relies on realization to grant it credibility as a physicalist account of the mind. So, it falls to an account of realization to show why it is that realized kinds, in particular mental kinds, belong to a physicalist ontology. An account of realization that fails to provide reasons why realized kinds are to be counted among a physicalist ontology undermines the appeal of functionalism. The importance of realization to the articulation of physicalist accounts also provides evidence for the importance to an account of realization that it shed some light on how realized kinds are realized by physical kinds.[4] In light of this, I propose my first desideratum:

1. The realization relation should support physicalism.

1. 2. 2. The argument from multiple realization

Though identity theory does an excellent job of presenting a thoroughly physicalist account of the mental, it is not without its problems. The main argument advanced by functionalists against identity theory is that it cannot account for the possibility of mental states being *multiply realized*.[5] This claim is expressed in the argument from multiple

[4] I am aware of no lists of desiderata nor account of realization that do not in some way reference the importance of connecting physicalism and realization.

[5] There are other objections to identity theory that I do not discuss. For example, type identity theory was initially proposed as an alternative to behaviourism, and as such there are challenges to identity theory

realization, which goes as follows:

> P1: There are many different kinds of beings, both possible and actual, (e.g., octopuses or extraterrestrials), that are capable of having mental states, (e.g., experiencing pain).
>
> P2: It is unlikely that all the possible and actual beings share the type of physical composition humans have, so it is unlikely that all the possible or actual beings are capable of being in the same kinds of physical states that human beings are in when they are in a particular mental state, such as pain.
>
> Sub-Conclusion: From P1 and P2 mental states are probably in a one-to-many (or many-to-many) relation to physical states.
>
> P3: Identity is a one-to-one relationship.
>
> Conclusion: Mental state types cannot be identical with physical state types if mental state types are related to physical state types in a one-to-many or many-to-many way.

An early version of this argument is advanced by Hilary Putnam (1973, 436-437). Putnam argues that the onus is on the defender of identity theory to explain how *every* type of mental state is identical with some unique type of brain state. Creatures capable of having mental states are sufficiently diverse so it is unlikely that those beings share similar kinds of physical states, which undermines the likelihood of identity theory. This argument appeals to the conceptual possibility that mental kinds *could* have multiple realizers, and that this possibility is ruled out by identity theory.

The argument against identity theory, in the first presentation I offered, made no mention of realization. Using the concept of realization the argument can be rephrased as:

> MR1: Mental kinds (states or processes) are multiply realizable.
>
> MR2: According to identity theory every mental kind has exactly one realizer.

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from behaviourism that I will not discuss. Examples of such objections can be seen in Smart (1959), looking specifically at objections 6 and 8 (152 and 153-154 respectively). As identity theory was originally proposed, the identities between mental processes and brain processes were contingent. This has been famously challenged, but I will also not raise any of the modal necessity arguments raised against identity theory (Kripke, 1980).

MRC: Identity theory is false.

This conclusion can be in part explained by the fact that realization is not a one-to-one relation.[6] Realization is a relation that holds between mental kinds and neural kinds. Realization picks out *all* the diverse possible physical states (or processes) sufficient for the instantiation of a particular mental kind. The physical facts constitute sufficient conditions for a given mental state (or process).[7] But, those physical facts are not necessary for the realization of a mental kind. Contrasting realization with identity highlights an important difference. According to identity theory the physical kinds are both necessary and sufficient for the mental kinds with which they are identical, whereas realization places fewer constraints on the connection between physical and mental kinds; a realizer must only be sufficient for the state that it realizes.[8]

1. 2. 2. 1. Identity or realization, and identity theory or functionalism; the role of empirical evidence in those debates

So far I have mentioned two relations that are competing candidates for what connection holds between mental kinds and physical kinds: identity and realization.[9] Contrasting

[6] My discussion of identity theory primarily addresses type identity theory. Alternatively, one might argue that a mental state is identical to a disjunctive set of physical states, and that each time a mental state of a particular kind obtains, it obtains because one member of the disjunctive set obtains. This kind of token physicalism is defended by Jaegwon Kim (1992; 2012). I will not explore this option further, but I note it here for completeness's sake. In a later section I discuss Kim's criticism of standard functionalist accounts based on the causal exclusion argument.

[7] A couple of examples of general descriptions of realization that endorse this characterization can be found in Baysan (2015) " . . .[T]he term "realization" has become an umbrella term to refer to some *dependence* relation between higher-level properties or states (or in some cases *descriptions*, rather than world items like properties or states) and lower-level properties or states in the following sense: the instantiation of a higher-level property or state depends on, and is necessitated by, the instantiation of its lower-level realizer (or realizers)." (Baysan 2015, 248), and Shoemaker provides a similar gloss of realization: "In general, X realizes Y just in case the existence of X is constitutively sufficient for the existence of Y – just in case Y's existence is "nothing over and above" X's existence." (Shoemaker 2007, 4)

[8] The argument from multiple realization has other uses beside being an objection specifically against identity theory. Jerry Fodor (1974), for example, argues for the autonomy of the special sciences from the basic physical sciences on the basis of multiple realization. Fodor's argument opposes reduction generally, and so indirectly rejects identity theory, but his argument has a wider scope than just the refutation of identity theory.

[9] Another relation that is used to characterize the relationship between mental and physical properties is supervenience. The supervenience relation is a dependence relationship whereby one property or set of properties, P, supervenes on another property or set of properties, Q, if a difference in P is possible only if there is also a difference in Q. Mental properties are described as supervening on physical properties, so a if all the physical properties are fixed, then so too are the mental properties. Supervenience is distinct from realization. To illustrate how, consider the case where a property has multiple realizers. If a

these alternatives on their own doesn't present a full picture of what choosing between the two relations involves. Identity is obviously tied to identity theory, but it is uncommon to discuss 'realization theory' as an alternative.[10] Functionalism is the account of mind that makes use of the realization relation to describe the relation between physical and mental kinds. These are alternatives for an account of the mind and the relation that holds between physical kinds and mental kinds that run in parallel to each other. Functionalists accept realization, and identity theorists endorse identity.

Identity theory makes claims not only about how mental and physical kinds are related, but also about the nature of the mental kinds themselves. Mental kind terms are indirect ways of referring to physical kinds. Mental kinds could, at least in principle, be replaced with descriptions of physical kinds. Or it might just be that mental kinds could be eliminated entirely, for failing to refer to anything in the correct physical ontology of the world. Parallels between the way that 'water' is identical with 'H_2O' or that 'heat' is identical with 'mean kinetic energy' are frequently invoked. Identity and identity theory go hand in hand; accepting that identity connects the mental and the physical has consequences for what one thinks the nature of the mental is.

On the other hand, if one relates mental and physical kinds via realization, it is not typically because one accepts 'realization theory'. Rather, realization and functionalism go hand in hand, and functionalism provides a theory of the nature of mental kinds. Functionalism defines mental kinds relative to their role within a system. A mental kind (state or process) is defined by the functional role the mental kind plays relative to particular inputs (e.g., perceptual experiences), outputs (e.g., overt behaviours), and to other mental kinds. Mental kinds, according to functionalism, are roles to be occupied within a system of interactions. The role that defines a mental kind is realized by certain physical kinds in particular instances. So long as a physical kind suffices to

property, A, is multiply realized by two other properties, B or C, then it is possible for A to differ without B differing, in cases where A is realized by C. And vice versa, if A is realized by C, then it is possible for A to differ without B differing. So A does not supervene on B and A does not supervene on C, but both B and C realize A. Multiple realization leave open the possibility that classes or sets of properties supervene on other sets or classes of properties. The issues surrounding the correct formulation of the supervenience relation are as complex as those regarding realization, and I do not attempt to provide an analysis of supervenience in my dissertation.

[10] An exception to this are Polger and Shapiro (2016) who expressly contrast identity theory and realization theory.

fulfil the role defined by the functional description of a given mental kind then that physical kind is a realizer of the mental kind. Many physical states might be able to fulfil the functional role that defines a mental state, so functionalism is compatible with multiple realization.

Functionalism and identity theory share the common commitment to explaining the causal powers of mental kinds. Discovering which systems possess which causal powers is an empirical question. Viewed in this light, the contrast between the two theories is the predictions they make regarding the kinds of systems found in the world; functionalism allows that there could be more than one system that possesses the relevant causal powers, identity theory predicts that those systems will be unique. Both views could be phrased in terms of realization: identity theory predicts that there will be unique realizers for every mental kind, whereas functionalism aligns itself with the prediction that we will discover (or have already discovered) multiply realized kinds.[11]

In principle functionalism is compatible with empirically discovering that each functionally characterized mental kind is identical with exactly one physical kind. Early proponents of identity theory aimed to make it clear that their view was to be understood as advancing an empirical hypothesis. For example, Place (1956) in one of the first examples of a defence of identity theory, introduces the view by stating, "The thesis that consciousness is a process in the brain is put forward as a reasonable scientific hypothesis, not to be dismissed on logical grounds alone." (Place 1956, 44) This is echoed by Herbert Feigl,

> Scientifically the most plausible view to date is that of a one-one (or at least one-many) correspondence of mental states to neurophysiological process-patterns. The investigations of Wolfgang Kõhler, E. D. Adrian, W. Penfield, D. O. Hebb, W. S. McCulloch, *et al*., all strongly confirm such a correspondence in the form of an isomorphism of the patterns in the phenomenal fields with the simultaneous patterns of neural processes in various areas in the brain. The philosopher must of course regard this isomorphism as empirically establishable or refutable, and hence as *logically* contingent. (Feigl 1960, 27)

[11] As Shapiro (2004) points out, there are several ways of thinking about what accepting multiple realization means in terms of predictions about the kinds of systems that might realize the causal powers of interest. There are, in short, weaker and stronger versions of the empirical predictions that can be made about multiple realizability of mental kinds.

Feigl focuses on showing that there is no logical problem with discovering empirically that a particular mental kind always corresponds to the presence of a particular neural kind.[12] His concern is with showing that the terms that describe mental concepts could correspond to neural activity without contradiction. When thought of in this manner, identity theory is a special or limit case of functionalism, where every mental kind just happens to have a single realizer. This illustrates that, at least in principle, the term 'realization' could be used to express a version of identity theory; accepting that realization is the relation that holds between the mental and the physical does not presuppose that it cannot turn out that there is a one-one correspondence between mental kinds and physical kinds. So, even if one's interest lies in defending identity theory, there is something to be gained by finding an account of realization that allows for this empirical hypothesis to be clearly expressed. Shaprio (2004) and Polger and Shapiro (2016), for example, advance views very much in this spirit. Whether one wishes to defend multiple realization, or to deny it, there is something to be gained by having a clear account of realization at hand.

However, re-describing identity theory in this manner changes the way that the argument from multiple realization applies in the debate between functionalism and identity theory. The fact that mental kinds are possibly multiply realizable does not threaten a more modest version of identity theory that makes the limited claim that mental kinds are not, in fact, multiply realized. There are several different claims that might be made regarding the possibility that mental kinds are multiply realizable, for example:

a) It is conceivable that mental kinds are multiply realizable,

b) It is metaphysically possible that mental kinds are multiply realizable,

c) It is nomologically possible that mental kinds are multiply realizable,

d) There are rare instances of multiple realization of mental kinds that occur in the actual world,

e) There are some instances of multiple realization of mental kinds in the actual world, but they occur in particular and constrained circumstances,

[12] It is worthwhile to take note that in this early presentation of identity theory by Feigl, he suggests that mental kinds may stand in a one to many relationship with physical kinds.

f) The multiple realization of mental kinds is common.

These options are by no means exhaustive.[13] Debates regarding the frequency of multiple realization of mental kinds revolve around a different kind of claim from those made in the original argument against identity theory based on multiple realization. There is a debate between those who hold that the empirical evidence supports the actual occurrence of multiple realization of mental kinds and those who hold that it undermines credence in supposed instances of multiple realization. Being able to express the positions on both sides of this debate using realization makes it clear which points are accepted by both sides and where there is disagreement.

Identity theory proposes that each mental kind is identical with a physical kind. As Putnam (1973) points out, if identity theory is correct then every mental kind is identical with exactly one neural kind, and every being that experiences a particular mental kind does so only because they are instantiating that exact neural kind. If, however, several distinct neural kinds could each suffice for the instantiation of a single mental kind, then there is a violation of the identity relationship. Neural kinds and mental kinds are not related in a one-to-one way, as identity requires, but rather mental kinds are realized by brain kinds in a one-to-many way. Early proponents of multiple realization appealed to the possibility that very different animals from ourselves, such as octopuses, and imaginary beings from science fiction, such as extraterrestrials or androids, could all experience the same mental states that human beings are capable of having. These radically different beings are either very unlikely to share the same neural states as us, as in the case of octopuses, or by stipulation they do not share any physical overlap with our own constitution, as in the case of aliens and androids.

However, the stipulation that extraterrestrials, androids, or robots can instantiate the same mental kinds that we can could be viewed as begging the question against identity theory. The assertion that many different creatures can all experience the same mental kinds requires it to be true that the mental kinds in question do not have a unique

[13] Thomas Polger proposes a different set of theses based on the possibility that mental kinds are multiply realized, which he calls 'Weak-MR', 'SETI-MR', 'Standard-MR', and 'Radical-MT' (Polger 2002, 146-147). These different options are ordered in terms of the degree of difference that an entity might have from us, and nevertheless realize the same mental kinds we are capable of realizing. Lawrence Shapiro takes up these different options and discusses the kind of evidence required for them (Shapiro 2004).

realizer, one that can only be instantiated by a single neural kind. The argument from multiple realization supports adopting functionalism. As such, functionalism should not be appealed to in support of multiple realization. This gets the direction of support backwards. This response to the argument from multiple realization, on behalf of identity theory, seems to produce a stalemate between identity theory and functionalism that is decided by individual intuitions. How strongly one feels the intuition that creatures radically different from ourselves can realize the same mental kinds will determine whether one finds the argument from multiple realization convincing or not.

One way to break the stalemate is by presenting new evidence about the way(s) that a mental kind is realized by human brains. If it is found that mental kinds always have unique realizers in humans, this would undermine, though not disprove, the hypothesis that mental kinds are multiply realizable. That is, it might be that multiple realization is only conceivably or metaphysically possible. A lack of any actual cases of multiple realization is indirect evidence against the view that mental kinds are multiply realizable. On the other hand, if in the course of neuroscientific research it is uncovered that some mental kinds have multiple realizers among different human beings, then there would be ample reason to accept that mental kinds are multiply realized. So, there is a clear role for empirical evidence to play in adjudicating the choice between identity and realization.

The debate regarding whether mental kinds are identical with certain physical kinds or whether physical kinds merely realize mental kinds can be phrased entirely in terms of realization. The question can be put as, do mental kinds have exactly one realizer or do some mental kinds have more than one (many) realizers? If mental kinds only have one realizer, then a modest version of identity theory is correct, whereas if some mental kinds have multiple realizers, then identity theory is incorrect. These opposing views can be interpreted as empirical hypotheses that make predictions about the number of realizers that mental kinds have (Polger and Shapiro 2016). For empirical evidence to play a role in deciding between identity theory and functionalism the two competing accounts must share a common way of describing the empirical evidence. For the concept 'realization' to be of use in presenting the two alternative hypotheses, it must not rule out

the possibility that mental kinds have a single realizer, nor can it rule out the possibility that mental kinds have multiple realizers.[14]

To have a place in articulating these empirical hypotheses, 'realization' cannot implicitly rule out one of the options as conceptually impossible. As such, an account of realization should allow for the possibility that realized kinds can have unique realizers. I advance this condition as my second desideratum:

2. Whether a kind is multiply realized should be decided on empirical grounds.

In the next subsection I address a central challenge to functionalism, the causal exclusion problem. The causal exclusion problem raises a challenge for functionalism by arguing that mental kinds, functionally conceived, lack causal powers that are taken to be individuative of them.

1. 2. 3. The Causal Exclusion Problem

The first two desiderata I advance are related to the way that realization connects physical kinds and mental kinds. The first desideratum focuses on how realization grants mental kinds legitimacy within a physicalist ontology. The second desideratum addresses the role of empirically gathered evidence in determining when the realization relation holds between mental and physical kinds. In the discussion of both desiderata the importance of the causal powers of mental kinds and their realizers was raised. The final desideratum also deals with causal powers of realized kinds and their realizers. It deals specifically with an objection against functionalism based on how mental kinds possess causal powers in virtue of their realizers.

Known as the causal exclusion problem, this objection argues that the realization conjoined with standard physicalist assumptions, reveals that mental kinds are superfluous or causally inert. The argument aims to show that realized kinds exert no causal influences on the world, only their realizers have genuine causal powers. In particular, mental kinds have no causal powers, so they have no roles to play in our ontology or our explanations. The causal exclusion problem is often presented in the form

[14] There are arguments that identity rules out the conceptual possibility for multiple realization. Saul Kripke argues that since identity is a necessary relation it cannot even be possible that a mental kind could have more than one realizer (Kripke 1980). I will not take up concerns regarding the modal properties of realization and identity here.

of a dilemma for defenders of realization, sometimes illustrated using a diagram similar to the one below:

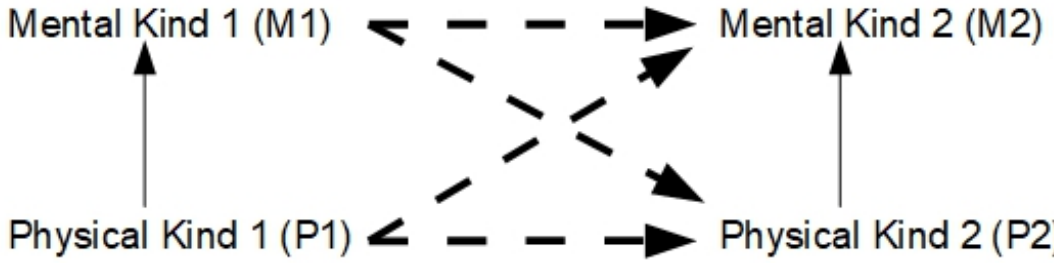

Figure 1: Basic causal exclusion diagram. The solid arrows represent the realization relation. The dashed arrows represent causal relations.

The diagram illustrates a general stylized case of a mental kind being realized by a physical kind. A mental kind, M1, is realized by a physical kind, P1. The mental kind M1 is assumed to be causally efficacious and apt to produce a particular effect, mental kind M2, i.e., M1 has the functional role within a system of causing M2. Mental kind M2 is realized by a physical kind, P2. M1 plays its causal role in virtue of its realizer P1. P1 is apt to cause P2, which realizes M2. M1 has the causal power to bring about M2 in virtue of its realizer, P1, being able to bring about the occurrence of a physical kind, P2, that realizes M2. This means that M2 is apt to be caused by both P1 and M1. But this means that M2 is caused twice, by both P1 and M1. On the basis of this set up there are two options to choose from, neither of which is appealing to a functionalist.

On the first horn of the dilemma, defenders of multiple realization can continue to insist that mental kinds are causally efficacious, in which case they are faced with an objectionable kind of over-determination; they must accept that mental kinds have two causes, a physical cause (P1) and a mental cause (M1), each of which is sufficient on their own to cause M2. This requires one to accept that mental kinds are always causally overdetermined, an unacceptable result to many.[15] On the other hand, one could deny that mental kinds cause other mental kinds. That is, M1 is not causally sufficient for M2. In this case, one denies the causal efficacy of the mental. In this case one can get by talking only about physical realizers. The second option, denying that mental kinds do any relevant or distinct causal work, undermines realism with regard to mental kinds. It

[15] An exception to this is Paul Pietroski (2000), who argues that over-determination is not unacceptably objectionable.

obviates the need to appeal to mental states when explaining how the mind interacts with the world.

There are other options for dealing with the causal exclusion argument than accepting one or the other horn of the dilemma. One solution is to deny inter-level causation (Bechtel 2017; Romero 2015; Craver and Bechtel 2007; Pietroski 2000). I explore what it means to deny inter-level causation and how this solves the causal exclusion problem in the next chapter, §2.1.4. and §2.3., I argue that there are accounts of realization which allow one to deny inter-level causation and that meet all three desiderata. In particular, I argue that one can deny inter-level causation and still advance an account of realization that respects the demands of physicalism (i.e., that meets the first desideratum).

The causal exclusion argument points out a pressing concern regarding the realization relation. It raises questions about the explanatory usefulness of invoking mental kinds. To show that realization is a viable alternative to identity for relating mental kinds to physical kinds, the account of realization should not undermine the possibility that mental kinds possesses causal powers. For accounts that define mental kinds in terms of their causal powers, the challenge is even more dire. If mental kinds are defined by their causal powers, yet mental kinds lack independent causal powers, as per the causal exclusion argument, then mental kinds serve no purpose at all. Mental kinds that are defined in terms of their causal roles must avoid the causal exclusion problem if they are to have any explanatory value at all. This provides the motivation for the third desideratum:

3. The account of realization should avoid the causal exclusion problem.

To review, there are three desiderata I advance based on the role the realization relation has played in debates in the philosophy of mind:

1. The realization relation should support physicalism,
2. Whether a mental kind is multiply realized should be decided on empirical grounds,
3. The account of realization should avoid the causal exclusion problem.

In the next chapter I review an example of an account of realization that meets the desiderata. Before showing that the desiderata can be satisfied, I consider some objections

raised against the adoption of my proposed desiderata.

1. 3. Objections to the proposed desiderata

In this section I address two objections to the desiderata I propose. First, I present Kevin Morris's (2010) argument that the only constraint an account of realization should conform to is that it support physicalism. Second, I address an argument by Tuomas Pernu (2014) which contends that one cannot both avoid the causal exclusion argument and defend multiple realization. I defend the desiderata from these objections.

1. 3. 1. Morris's objection

Morris (2010) notes that until recently only a few detailed accounts of realization have been advanced since the term came into use in the philosophy of mind (e.g. Shoemaker, 2007; Melnyk 2003; Polger 2004, 2007), and even less attention has been paid to the way that those accounts could be assessed. Morris considers three desiderata that could be used to decide between these accounts of realization, but argues that there is only a single metric by which we should evaluate realization: he argues that an account of realization ought to explain physical supervenience. The desideratum that Morris endorses is that an account of realization should, non-trivially, explain why a realized kind is necessitated by its realizer.[16] This requirement is similar in spirit to the first desideratum I advance. Morris presents his requirement for an account of realization as,

> This can be put as the suggestion that a theory of realization ought to have the consequence that physical realization account for, or explains physical supervenience. That is, physical realization should account for why instances of realized properties are necessitated by the physical way the world is. (Morris, 2010, 400)

As I noted in §1.2.2., a realizer is sufficient for the property that it realizes. Morris endorses a more precise and stronger version of my first desideratum, but he denies that there are any other desiderata an account of realization should meet.[17] In this section I

[16] Morris notes that an account of realization could trivially explain why some properties supervene on or are necessitated by others by using these concepts in the definition of realization. But an explanation of realization in terms of supervenience would not shed light on how realization makes certain properties acceptable to physicalism; the use of supervenience in the definition would be doing that work (Morris, 2007, 398-399).

[17] The two alternative desiderata Morris rejects are, (1), that an account of realization should support non-

focus on the criticism Morris raises against my second desideratum. Put generally, the concern Morris has with my second desideratum is not that it is incorrect or false, but rather that it is unnecessary.

As I noted at the beginning of the introduction, the goal of naturalizing the mind is one of the broad philosophical goals that motivates both identity theory and functionalism. Morris places this goal front and centre by requiring of an account of realization that it "confer physicalistic acceptability." (Morris 2010, 396) The purpose of the realization relation, as Morris sees it, is to show how properties that are not obviously physical properties are nevertheless acceptable to a physicalist. Part of meeting this requirement, Morris argues, is that it should explain physical supervenience. While physicalism is the core metaphysical view that Morris relates to realization, he acknowledges the historical connection between realization and functionalism. However, Morris takes the connection between functionalism and realization to be incidental. He grants that it may be a historical fact that some philosophers believed that the realization relation might provide a way to defend a non-reductive version of physicalism, "But this is quite different from supposing that a theory of realization is viable only if [it] provides a notion that can be utilized to formulate a viable nonreductive physicalist position." (*Ibid*, 402-3)

Morris rejects requiring of an account of realization that it support any particular kind of physicalism. Identity theory, a clearly physicalist position, is threatened by the argument from multiple realization, so it may be that my second desideratum covertly entails that an account of realization supports a particular version of physicalism. Morris considers whether a requirement relating to multiple realization should be made for an account of realization,

> Similarly, it might be claimed that an account of realization should make sense of the multiple realizability of at least some properties. That is, realization should be compatible with multiple realization. But while I do not think we should reject a kind of multiple realizability constraint on realization, such a constraint will not be of much use, since all extant

reductive physicalism (Morris 2010, 402), or (2), that "an account of realization is viable to the extent that it accommodates paradigmatic cases of realization." (*Ibid*, 404). I will not discuss the arguments Morris presents for rejecting these desiderata, my discussion focuses on a defence of the desiderata I advance.

> accounts are apparently compatible with realized properties having diverse physical realizers. (Morris 2012, 405)

Morris's denial of the need to include a desideratum about multiple realization does not stem from an objection to the way multiple realization may rule out some physicalist views. Rather, he thinks that acknowledging the connection between realization and multiple realization is superfluous. Morris reasons that if no account of realization rules out the possibility of multiple realization, adding a desideratum that relates to multiple realization won't rule out any accounts of realization, so a desideratum to that effect serves no purpose.

1. 3. 1. 1. Reply to Morris's objection

I respond to Morris's claim that my second desideratum serves no purpose in two ways. First, by emphasizing how distinguishing realization from identity is a significant aspect of the realization relation. Second, I show how my second desideratum places an emphasis on empirical considerations related to multiple realization that inform current debates about naturalizing the mind. The two considerations I raise in support of my second desideratum also address the concern that my desiderata unjustly favour non-reductive physicalism or undermines reductive physicalism.

Multiple realization was first proposed as part of an argument against identity theory. Any version of identity theory that precludes the *possibility* of multiple realization is a version of reductive physicalism ruled out by my second desideratum. That is, the second desideratum rules out any claims that identity theory is necessarily true.[18] So, while I accept that it is too strong of a constraint that an account of realization rule out *any* reductive physicalist account, I think, contrary to Morris, that at least some reductive physicalist accounts are excluded by my second desideratum. The question, then, is whether the inclusion of a desideratum that does so is acceptable. But, at the very least it is not entirely superfluous, as Morris suggests.

The only requirement of an account of realization Morris makes is that it explains why certain properties that are not fundamental physical properties are acceptable to

[18] I take this to be in keeping with the spirit of the original proposal of identity theory as an empirical hypothesis.

physicalism.[19] But this was never the sole purpose of realization. Realization is distinguished from other possible relations that might hold between fundamental and non-fundamental properties (e.g., functional properties) because it gives different characterizations of those connections. One way that realization differs from identity is that identity is symmetric, whereas realization is not. To illustrate why the difference between a symmetric and an asymmetric relation is important in this context, consider the following case: if two properties are identical, e.g. a mental property (higher-level property) and a physical property (lower-level property), then the physical property necessitates the mental property and *vice versa*, whereas if a physical property realizes a mental property, then the mental property is necessitated by the physical property but the physical property is *not* necessitated by the mental property. So, when properties are related via identity a higher-level property can necessitate the presence or occurrence of a lower-level property, whereas realization does not have the result that higher-level properties necessitate particular lower-level ones. This is a point to which I will return when discussing Robert Francescotti's objection to subset accounts of realization in the next chapter, §2.2.1.

Morris is likely correct that any account of realization will be compatible with multiple realization, but this is only to note that every successful account of realization will not rule out multiple realization. Since the possibility of multiple realization is one of the important characteristics that distinguishes realization from identity, any physicalist account that necessarily entails a one-to-one correspondence between kinds at different levels is ruled out by my second desideratum. My second desideratum says more than just that an account of realization must preserve the logical coherence of multiple realization. The desideratum states that any claim about a property being multiply realized should be decided on empirical grounds. It is a matter of scientific investigation into systems possessing certain properties whether those systems are homogenous or heterogeneous in

[19] Of course an account of realization should not render all properties acceptable to physicalism, there are some properties that are correctly not acceptable to physicalism. I cannot offer a positive account of how we are to sort properties into those that are (or should be) and those that are not (or should not be) acceptable to include in a physicalist ontology. Nevertheless, some properties such as liquidity, solidity, or having a mass of 1kg are all not fundamental physical properties that should presumably be acceptable to physicalism. Morris's account of realization aims specifically to explain how and why realization shows those properties to properly belong among a physicalist's ontology.

their composition or structure. There are predictions that can be made regarding the likelihood of the presence of a type of structure or composition based on the property of interest, but the kinds of constraints that there are on whether a system displays that property or not will be discovered by empirically testing that system.[20] Or conversely, whether two systems or entities that exhibit the same functional property share the same composition and structure will be determined through empirical investigation of those systems (or entities). Both Shapiro (2004) and Polger (2004) raise arguments against there being multiply realized mental properties based on empirical considerations. The second desideratum I defend elucidates the role realization plays in presenting and discussing these kinds of arguments without presupposing that mental properties must in fact be multiply realized. By drawing attention to empirical evidence and the arguments based on that evidence my second desideratum makes the role of the realization relation in this debate explicit.

The remaining concern is that my second desideratum rules out some versions of reductive physicalism when it should not. I am in agreement with Morris that an account of realization will not and should not, on its own, decide between reductive or non-reductive physicalism. However, he does admit that accounts that meet his physicalist constraint "are better viewed as being at the service of the reductive rather than the nonreductive physicalist..." (Morris 2012, 403).[21] So, it appears that Morris does not object to a desideratum biasing accounts of realization toward some versions of physicalism on their own. Based on Morris's earlier assertion that every account of realization is compatible with multiple realization, it follows that Morris accepts that there are some accounts of reductive physicalism compatible with multiple realization.[22]

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[20] Polger (2004) advances the Mental Constraint Thesis (MCT) as an alternative to the multiple realization thesis. He argues that mental processes or states are embedded in a complex system that involves evolutionary, developmental, and physical constraints that, when taken together, severely limit the number of different ways that any mental kind could be realized. These types of constraints are discovered through empirical testing to reveal what is required for a kind to be realized. An example of two systems that must be investigated to discover whether they are different realizations of the same mental kind are the visual systems of humans and octopuses. Polger and Shapiro (2016) argue that the eyes of humans and octopuses are not relevantly different, which they count as evidence against the multiple realization of seeing by humans and octopuses.

[21] Morris is unsure whether Shoemaker's subset account should be viewed as reductive or nonreductive, a point to which I return when I discuss Shoemaker's account (*Ibid*, footnote 17, 403).

[22] The connection between functionalism, reduction, and realization is an area of ongoing philosophical

My second desideratum does not, therefore, rule out all versions of reductive physicalism that one might want to entertain. It does rule out views that deny the *possibility* of multiple realization, but any such views will probably entail that realization is impossible. A desideratum for any account of realization does not need to accommodate views that deny its logical possibility. It could be up for debate whether realization is logically possible in a different setting, but if one concludes that realization is impossible, then no desiderata for an account of realization could be satisfied or useful.

My aim in this section was to show that my second desideratum, that an account of realization should have the result that whether a kind is multiply realized should be decided on empirical grounds, is not unnecessary. Explicitly acknowledging the connection between realization and multiple realization rules out some versions of physicalism. However, there remains some reductive physicalist accounts that are not excluded by this criterion. One example comes from the challenges that Polger and Shapiro (2016) raise against multiple realization based on empirical considerations drawn from neuroscience and cognitive science. They advance a view they call 'modest identity theory' that aims to occupy the conceptual space of being a non-reductive version of identity theory (Polger and Shapiro 2016). Moreover, my second desideratum draws attention to the evidence that is of central importance to the arguments raised by Polger and Shapiro. In this way, the second desideratum highlights the role the realization relation plays in shaping debates between viable versions of physicalism by drawing attention to the kind of evidence that is important in assessing various versions of physicalism.

1. 3. 2. Pernu's objection

Tuomas Pernu (2014) argues that there is a tension between the final two desiderata I propose; any account that avoids the causal exclusion problem must reject multiple realization, or any account that accepts multiple realization will run afoul of the causal exclusion problem. In effect, the last two desiderata I defend are incompatible. To illustrate how these two conditions conflict Pernu draws on work by Shapiro (2010;

discussion. Papers by Bechtel, Melnyk, and Polger in De Jong and Shouten (2007), for example, all discuss how these concepts fit together.

2012) to argue that, in particular, causal functionalist accounts of realization which avoid the causal exclusion problem must reject multiple realization. The argument Pernu advances proposes that if one adopts an interventionist account of causation, denying causal exclusion and multiple realization are necessarily in tension.[23] Since Pernu's argument relies on accepting the interventionist analysis of causation, one way that I might avoid his argument is to simply reject that analysis of causation and adopt another. However, in the absence of any commitment to the contrary, it seems possible that an interventionist account of causation could be worth adopting. Other things being equal, it would be preferable if the desiderata I propose for an account of realization did not have far reaching metaphysical consequences about the nature of causation and which account(s) of causation could be accepted.

For the moment, I present a brief summary of the interventionist account of causation and advance an argument that aims to show that even if an interventionist account of causation is adopted, there is a consistent way of meeting both desiderata. Following Pernu, I consider the analysis of causation offered by Woodward (2003). Interventionist accounts define causation as,

> A necessary and sufficient condition for *X* to be a direct cause of *Y* with respect to some variable set ***V*** is that there be a possible intervention on *X* that will change *Y* (or the probability distribution of *Y*) when all other variables in ***V*** beside *X* and *Y* are held fixed at some value by interventions. (Woodward, 2003, 55; quoted in Pernu, 2014, 526a)

The key to the interventionist notion is that if the value of one variable in a system is changed (and nothing else is altered) and that results in a change to some other variable, then the change to the altered variable is the cause of the change in value of the other variable. Applying this notion of causation, Pernu argues that one cannot hold an interventionist account of causation and avoid the causal exclusion problem while also endorsing multiple realization.

To illustrate why, Pernu considers a case where a mental property, M1, is multiply

[23] The focus on interventionist accounts of causation is important to my broader goal of integrating an account of realization with Craver's account of mechanistic explanation. Craver adopts an interventionist account of causation (Craver 2007, 93-106), so showing that an interventionist account of causation does not preclude the possibility of multiple realization is necessary to show that Craver's account of mechanistic explanation is compatible with multiple realization.

realized. Among its realizers is a physical property, P1. Pernu draws upon a description of multiple realization endorsed by List and Menzies (2009). They describe the abstract formula for cases of multiple realization where manipulation of a realizer does not change the property with which it is supposedly causally connected. They call these cases where causation is *realization-insensitive*. To spell out how such a case might work, suppose the following: a mental property, MP1, is identified by its being apt to bring about another mental property, MP2. Suppose also that MP1 can be multiply realized by two different physical properties, PP1 and PP1*. PP1 and PP1* must both be such that they are capable of causing a physical state that realizes MP2. There are two ways for this to be the case, either PP1 and PP1* are both possible causes of a physical property, PP2, that realizes the mental property MP2, or PP1 causes a physical property PP2 that realizes MP2 and PP1* causes a physical property PP2* that also realizes MP2. Figure 2 illustrates the first option, and Figure 3 the second.

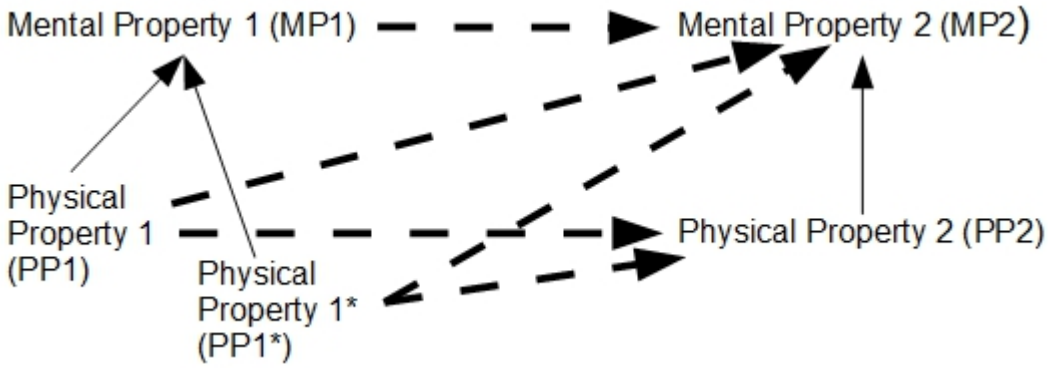

Figure 2: Causal exclusion with multiple antecedent realizers. MP1 is multiply realized but MP2 is not. Solid black arrows represent the realization relation. Dashed arrows represent causal relations.

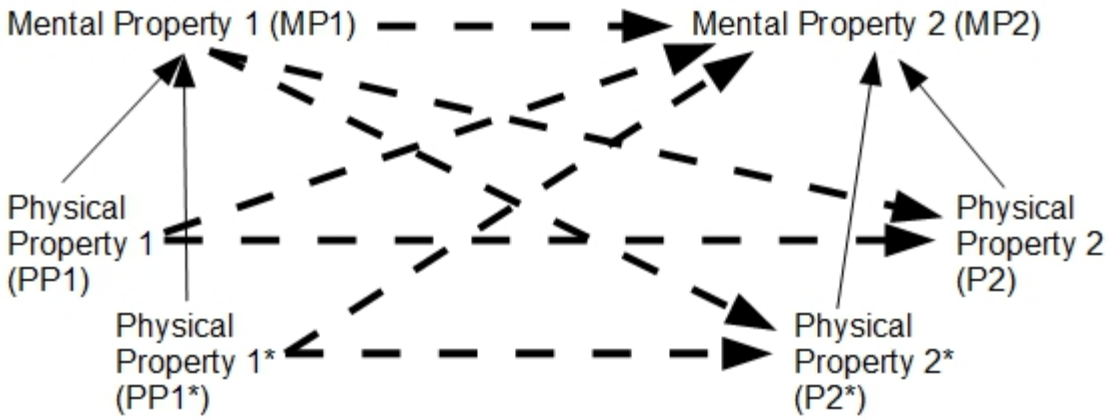

Figure 3: Causal exclusion diagram where both the antecedent and result are multiply realized. MP1 and MP2 are multiply realized. Solid arrows represent the realization relation. Dashed arrows represent causal relations.

In both cases an intervention on PP1 can fail to produce a change in MP2. What could happen is that an intervention on PP1 occurs, but MP1 is realized by PP1*, PP1* goes on to cause either PP2 (as in Figure 2) or PP2* (as in Figure 3) and either PP2 or PP2* realizes MP2. So, there are possible interventions on PP1 that would not result in changes in MP2, so PP1 is not a cause of MP2.

Pernu assumes that if MP1 is multiply realizable, then MP2 will also be multiply realizable and discusses only the case illustrated in Figure 3, but his argument applies equally to the cases illustrated in Figure 2 and Figure 3. The general problem with cases of multiple realization is that the description of their causal interactions violates the interventionist requirements used to identify instances of causation. The interventionist account requires that, for a property (PP1) to count as the cause of another property (MP2), an intervention on that property, PP1, will necessitate a change in the property it causes, MP2. Cases of multiple realization do not follow that pattern; in the cases represented in Figures 2 and 3, there are possible interventions on PP1 which do not affect MP2, those cases where MP1 is realized by PP1* (Pernu, 528). On this basis Pernu concludes that avoiding the causal exclusion problem and multiple realization are incompatible. In these cases, it is possible to treat MP1 as still causing MP2. However, it would appear that to do so requires denying that PP1 or PP1* is a cause of MP2. This is unappealing, since MP1 has the causal properties it does because it is realized by the

relevant physical property (PP1 or PP1*), but neither is a cause of MP2 according to the interventionist account of causation.

Shapiro's solution to this dilemma is to deny multiple realization. When there are differences in the causal powers of mental properties such that there are differences in the ways that the realizers of those mental properties causally interact with physical properties, then we can distinguish the mental properties as well. Whether this conclusion is acceptable, "must depend on the detailed reasons why it is impossible to intervene on *M* without simultaneously intervening on *P*. This in turn depends on how exactly one perceives the relationship between *M* and *P*." (*Ibid*, 527a) Pernu argues that Shapiro sees the relationship between *M* and *P* as one where the presence of *P* necessitates the presence of *M* (this, is a typical gloss on the realization relation), but that additionally the presence of *M* necessitates the presence of *P*. The kind of bi-directional necessitation claim solves the causal exclusion problem, but it does so by making what amounts to an identity claim. Pernu also notes this fact,

> What is essential is that Shapiro (2012) is committed to treating these two [M1 and P1] as identical *causal variables*; for what the mutual necessitation clearly entails is that mental properties and their realizers are manipulatively identical. If *P* and *M* necessitate each other, there is no way to escape the conclusion that any intervention on *P* is an intervention on *M*, and vice versa. What this entails, in turn, is that mental properties and their realizers are causally identical. (Pernu, 2014, 527b)

As Pernu points out, Shaprio's solution to the problem of causal exclusion is to advance a kind of identity theory. Of course, causal exclusion was never a problem for identity theory, so that a version of it solves the causal exclusion problem is no surprise at all.

An alternative solution would be to deny that mental properties (MP1) cause the physical properties of the realizers of the other mental properties (PP2 or PP2*), and that the physical properties (PP1 or PP1*) cause subsequent mental properties (MP2). In the case of the three previous diagrams (Figure 1, Figure 2, and Figure 3), we could modify them to appears as Figures 4, 5, and 6 respectively:

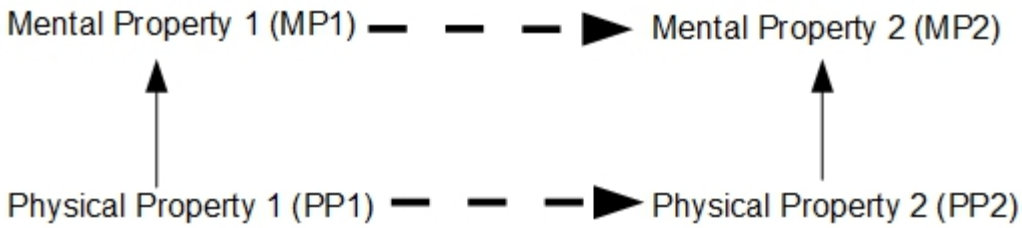

Figure 4: Causal exclusion diagram without inter-level causation. Solid arrows represent realization. Dashed arrows represent causal relations.

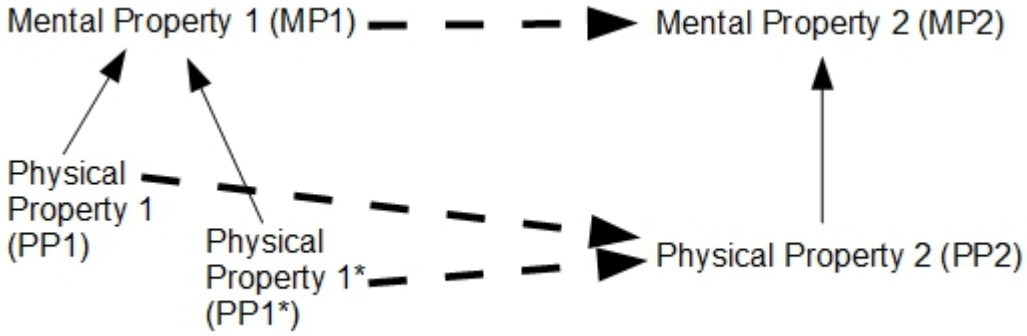

Figure 5: Causal exclusion diagram where the antecedent is multiply realized, without inter-level causation. MP1 is multiply realized, MP2 is not. Solid arrows represent the realization relation. Dashed arrows represent causal relations.

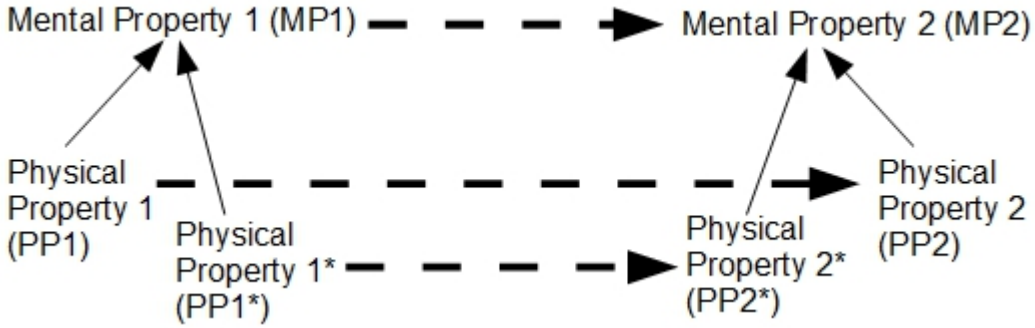

Figure 6: Causal exclusion diagram where both the antecedent and the result are multiply realized, without inter-level causation. MP1 is multiply realized and MP2 is multiply realized. Solid arrows represent the realization relation. Dashed arrows represent causal relations.

When modified in this manner, there is no threat of over-determination in the cases where mental properties are multiply realized. This solution may seem appealing, but Pernu worries that it rules out inter-level causation. M1 is a cause of M2, but it is not a cause of P2 or P2*, since a manipulation of M1 does not guarantee a change of P2 or P2*.

Multiple realization is saved at the cost of inter-level causation,

> That is, physical properties never cause the presence of mental properties and mental properties never cause the presence of physical properties. What this means in terms of the causal exclusion problem depends on what exactly one thinks the problem amounts to. On the one hand there is no mental to physical causation. If the causal exclusion argument purports to the impossibility of such downward causation, then the argument can actually find support from these results. But on the other hand, there is no physical to mental causation either. So if physicalism is thought to be committed to the idea that physical properties are causally responsible for the presence of mental properties, then such a tenet turns out to be unwarranted in the light of these results. (Pernu, 2007, 529b-530a)[24]

At this point it seems there are two choices, accept a version of identity theory, or deny inter-level causation. I favour the latter solution. In the next chapter I discuss why one should give up inter-level causation. Using Shoemaker's account of realization I argue that there is no threat to physicalism or to the existence of mental properties in denying inter-level causation as it is here characterized.[25] Shoemaker's subset account of realization keeps properties and their realizers as distinct entities (they are not causally identical), and navigates around the causal exclusion problem by making a realized property instance part of the realizer property instance. This prevents causal powers from being duplicated. In the next chapter I present in greater detail Shoemaker's view, and return to his solution to the causal exclusion problem once I summarize necessary details of his account.

1. 4. Dissertation outline

As I noted at the outset of this chapter, my dissertation is divided into three main chapters. The next chapter takes the desiderata and applies them to a detailed account of

[24] There is a slight bit of ambiguity in the last sentence of this quote. Pernu comments that physical properties are causally responsible for mental properties, but one might think that physical properties realize mental properties rather than cause them. What seems likely is that Pernu has in mind that physical properties cause subsequent mental properties and that we should interpret his comment as applying to diachronic cases. In terms of the diagrams I have been using to illustrate different interpretations of the causal exclusion argument, Pernu can be taken as talking about the PP1 causing MP2 in figures 2 and 3.

[25] Rejecting inter-level causation raises its own set of problems. In Section 3.5 I present Gillett's objection to subset accounts of realization (Gillett 2002; 2003). There I present additional details of Shoemaker's account, and argue that his account preserves a relevant sense of inter-level realization compatible with the denial of inter-level causation in the sense that I deny it here.

realization. I present Sydney Shoemaker's (2007) account of realization and describe how his account meets the desiderata I presented in §1.2. of this chapter. I use Shoemaker's account of realization as a case study of what is needed in an account of realization to meet the desiderata and to explore what consequences for the metaphysics of mental kinds there might be for adopting an account of realization that meet the desiderata I've advanced. The third chapter explores some recent arguments against multiple realization. These arguments focus on the role empirical evidence drawn from neuro- and cognitive science plays in the debate between functionalism and identity theory (or between identity and realization). In the fourth chapter I respond to these critiques of multiple realization by presenting examples of multiply realized mental kinds drawn from research on the cognitive neuroscience of language. The next three subsections provide more detailed outlines of the each of the chapters.

1. 4. 1. Chapter Two: A sample assessment of an account of realization: Shoemaker's account of realization and the three desiderata

In the next chapter I describe Sydney Shoemaker's account of multiple realization. I do so for two main reasons: first, to demonstrate that the desiderata I propose are not so demanding that they cannot be jointly satisfied, and second, by describing the features necessary to consistently meet the desiderata, I draw to light some of the issues and consequences surrounding the adoption of a particular account of realization. As the objection to the desiderata by Pernu I addressed in §1.3.2 brings to the fore, there is a tension between kinds being multiply realized, and those same kinds having well defined causal powers. In describing Shoemaker's account I highlight how his account deals with the causal exclusion problem, and how the manner by which he deals with that problem meshes with a way of allowing for multiply realized, causally individuated, properties.

I conclude by addressing some objections to Shoemaker's account. The first objection I address is raised by Robert Francescotti (2010). Francescotti argues that Shoemaker's account fails to meet the first desideratum. Francescotti argues that an account of realization should give priority to physical kinds, such that mental kinds are realized by physical kinds, but not vice versa. In response, I show how Shoemaker's

account preserves the required asymmetry. Second, I address an issue raised by Carl Gillett (2002, 2003). Gillett argues that some accounts of realization, Shoemaker's included, cannot adequately accommodate the realization of emergent properties. According to Gillett, accounts of realization where the realizer (R) and the realized kind (K) must share the relevant property for R to realize K fail to describe many common examples of realization. In response to this concern, I show how Shoemaker's account deals with the realization of emergent properties. I conclude that since there is at least one viable account of realization that meets the desiderata I advance, that the desiderata are not too demanding.

1. 4. 2. Chapter Three: Empirically motivated arguments against multiple realization

Though acceptably detailed accounts of realization have been articulated and defended, this alone does not secure the position that mental kinds are multiply realized. Opponents of the occurrence of multiple realization such as Thomas Polger and Larry Shapiro have advanced plausible accounts of realization, but reject the view that mental kinds are multiply realized (Polger and Shapiro 2016; Polger 2004; Shapiro 2008, 2000). Their denial that mental kinds are multiply realized is based on the failure to empirically discover cases of multiply realized mental kinds, rather than on objections to the coherence or logical possibility of realization holding between mental and physical kinds. In this debate the fate of multiple realization with respect to mental kinds is to be decided on the basis of empirical considerations. I am in agreement with the emphasis on empirical findings in assessing examples (or failed examples) of multiple realization. However, contrary to the conclusion Polger and Shapiro reach regarding the dearth of examples of multiple realization in the neuro- and cognitive sciences, I argue that there are instances of multiple realization that have been discovered.

In this chapter I lay out some current arguments against cases of multiple realization. I discuss the Grain Argument as it is proposed by William Bechtel and Jennifer Mundale (1999). The Grain Argument proposes that many apparent examples of multiple realization are not, in fact, actual cases of multiple realization. These examples

only appear to be cases of multiple realization due to a mismatch in the level of descriptive detail given for the mental kind and its, supposed, realizers. According to Bechtel and Mundale, mental kinds are given broad general descriptions, but they are matched to multiple fine-grained descriptions of neural realizers. When mental kinds are described with an appropriate or matching degree of detail to the descriptions given of neural kinds, the appearance of multiple realization evaporates. Next, I present Lawrence Shapiro's argument against multiple realization, which comes in the form of a dilemma for defenders of multiple realization (Shapiro 2008, 2000). Shapiro's dilemma aims to show that either there are relevant differences among realizers of a particular kind (and so should not be classified together), or there are no relevant difference among realizers (in which case, there is just a single kind of realizer). Finally, I review four strategies used by Polger and Shapiro as defeaters for examples of multiple realization: Unification, Individual Differences, Kind Splitting, and Abstraction and Idealization (Polger and Shapiro 2016). As well as looking at Polger and Shaprio's negative conditions on multiple realization, I review their positive definition for cases of multiple realization.

1. 4. 3. Chapter Four: Examples of multiple realization drawn from the cognitive neuroscience of language

In this chapter I present empirically discovered examples of multiple realization drawn from the cognitive neuroscience of language. There are three research areas within the cognitive neuroscience of language that I draw upon for my examples of multiple realization: research into language lateralization, reading acquisition, and bilingualism. I use research in each area to contrast genuine and apparent cases of multiple realization, illustrating what empirical evidence is required to vindicate or overturn potential cases of multiple realization. I argue that in all three research programs there is evidence for cases of multiple realization that meet the desiderata I advanced in the introduction. Additionally I argue that the examples meet the conditions for multiple realization defended by Polger and Shapiro for genuine cases of multiple realization. Using the case studies from language research I show how the examples of multiple realization I present are not vulnerable to the Grain Argument, Shapiro's dilemma, or the four strategies of

Polger and Shapiro, Unification, Individual Differences, Kind Splitting, or Abstraction and Idealization. I conclude that in light of the various examples of multiple realization I defend, there is good empirical evidence in favour of multiple realization of mental kinds related to language.

1. 4. 4. Chapter Five: Concluding remarks on the (multiple) realization of mental kinds by mechanisms

In the concluding chapter I propose directions for further research about the multiple realization of mental kinds. I remark on the importance of empirical evidence and specific case studies in assessing accounts of realization and mental kinds. The relevance of empirical evidence in assessing the debate between functionalism and identity theory invites functionalists to take a new perspective on the importance of realizers. The information about how our brains, nervous systems, and bodies operate that psychologists, cognitive scientists, and neuroscientists are discovering has shed light on our understanding of mental and psychological kinds. This success might tempt some, as Thomas W. Polger, Lawrence A. Shapito, and William Bechtel are, to reconsider the viability of identity theory. However, if one accepts that there are multiply realized mental kinds, as the examples in chapter four show, then identity theory is a non-starter. Instead of a return to a modified version of identity theory (a kinder and gentler version of identity theory, such as the modest identity theory Polger and Shapiro defend), I consider how a functional account of mental kinds could incorporate the relevance of realizers. To that end, I suggest that consideration should be given to the way that functionalism fits with new mechanism. New mechanism is, broadly speaking, a view on how to explain the occurrence of observed phenomena originating in the philosophy of science (particularly the philosophy of neuroscience and philosophy of biology). The account of explanation supposes that scientists proceed by seeking to understand how mechanisms produce or sustain a phenomenon. A target phenomenon is described as having characteristic start up and finishing conditions. Mechanistic explanations describe how component entities of a mechanism participate in a series of activities that take the start up conditions as an input and generate the characteristic output. One way of

describing this goal is to say that the aim is to discover how a mechanism *realizes* a phenomenon. Thinking of mechanisms as the realizers of mental kinds opens up the ability to ask questions about whether mechanisms, or their component entities and activities, are multiply realizable, and about how mechanistic explanations deal with phenomena that are multiply realized.

Chapter Two: A sample assessment of an account of realization: Shoemaker's account of realization

2. 1. Introduction

In this chapter I summarize a fully developed account of realization, the account proposed by Sydney Shoemaker (2007), to demonstrate that the desiderata I advance can be consistently met. I treat Shoemaker's account of realization as a case study of what is needed to meet the desiderata. To begin this section, I present some basic features of Shoemaker's account of realization and provide a simplified and schematic example of a case of realization that conforms to his account. As I describe additional details of Shoemaker's account needed to meet the desiderata and to avoid objections raised against it, I progressively add details to the example.

Realization, as it was originally proposed, was used to relate states, a physical state was said to be the realizer of a mental state. However, realization can hold not only between states but also between properties. This way of thinking about realization has become common in recent debates (see Baysan (2014) for a review of the variety of positions that focus on realization as holding between different kinds of properties). Shoemaker's account of realization focuses on the realization of properties by other properties. He individuates properties on the basis of their causal profiles. Which is to say, properties are picked out based on what the likely causes are for a property, and what the property is likely to cause; Shoemaker refers to these as a property's backward-looking causal powers and its forward-looking causal powers, respectively. As such he calls his view a subset account of property realization since the causal powers of a realized property are a subset of the causal powers of its realizer.

2. 1. 1. Shoemaker's account of realization

In this subsection I show how Shoemaker's account meets the three desiderata from the previous chapter. I start by providing an outline of his account and, as I show how it meets the desiderata, add details as necessary. The initial characterization he provides for his view is:

> Realized properties as well as their realizers will have causal profiles, and realization consists in there being a certain kind of relation between the causal profile of the realized property and the causal profile of the realizer. As a first approximation, property P has property Q as a realizer just in case (1) the forward-looking causal features of property P are a subset of property Q and (2) the backward-looking causal features of P have as a subset the backward-looking features of Q. In a particular case an instantiation of property P is realized by an instantiation of property Q just in case P and Q are instantiated in the same thing and Q is a realizer of P. Call this the "subset account." Shoemaker, 2007, 12.[26]

Already this definition is fairly complex, so to make it somewhat less obscure, I illustrate how Shoemaker's account of realization connects a realized property with its realizer using an example.

The realized property in this example is the property of being a kettle filled with boiling water.[27] The property of being a kettle filled with boiling water is a complex, higher-level property that allows me to illustrate how lower-level properties realize it without descending into the realm of microphysics or other complex areas of scientific investigation. The property of being a kettle filled with boiling water has certain obvious backward-looking and forward-looking causal powers. The backward-looking causal powers include being filled with water, being able to contain that water, and having a source of heat applied to the contained water to bring the water to its boiling point. The forward-looking causal powers of a kettle filled with boiling water include the production of water vapour, bubbles forming in the liquid, and the ability to dissolve certain substances.[28] For the following examples, I name the property that has these forward- and backward-looking causal powers *Boiling Kettle*. An electric kettle, when plugged in, filled with water, and turned on, realizes *Boiling Kettle* by heating the water in the kettle, by containing the water and passing an electrical current through a heating element. Call the

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[26] Shoemaker flags this version as provisional primarily because it is vulnerable to the following problem: any conjunction of two properties will be a realizer of one of the conjuncts. I will not discuss his solution to this particular problem, as it is not relevant to the issues raised by the other views discussed in this paper.

[27] Using examples of manufactured kinds is a common practice as a way to illustrate the realization of properties. For example, Shapiro (2004) and Polger and Shapiro (2016) frequently discuss corkscrews and watches.

[28] There more factors than this that define the physical property of boiling, but for the purposes of the example suppose that we can set those aside.

particular property of an electric kettle due to its containing shape and action of its electrical element *Electric Kettle*. *Electric Kettle* realizes *Boiling Kettle* because it has the relevant backward-looking causal powers that are a subset of the backward-looking causal powers of *Boiling Kettle*; *Electric Kettle* adds energy to the water it contains to raise the water's temperature to its boiling point, and *Electric Kettle* has the forward-looking causal powers of *Boiling Kettle* as a subset of all of its forward-looking causal powers; the water contained in my kettle, when it is turned on, bubbles and steam rises.

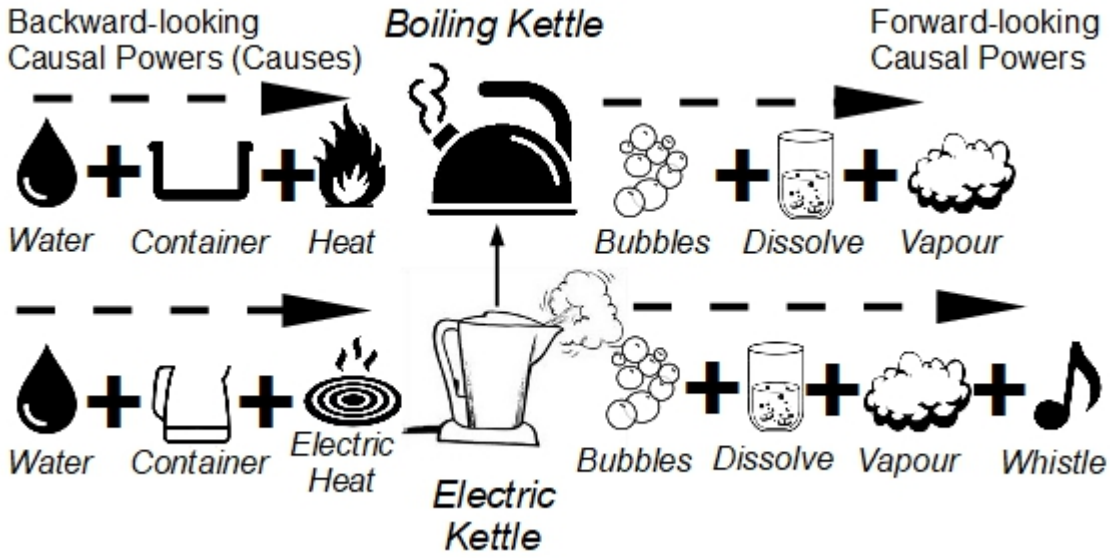

Figure 7: Kettle realization diagram. The solid arrows represent the realization relation. The dashed arrows represent causal relations. 'Water', 'Container', 'Heat', and 'Electric Heat' are backward-looking causal powers. 'Bubbles' 'Dissolve', 'Vapour', and 'Whistle' are forward-looking causal powers. 'Boiling Kettle' and 'Electric Kettle' are properties that possess the forward-looking and backward looking causal powers in line with them.

The forward-looking causal powers of *Electric Kettle* have, as a subset, the forward-looking causal powers of *Boiling Kettle*. That is, *Electric Kettle* has all the forward-looking causal powers individuative of *Boiling Kettle*, as well as additional causal powers. For example, an electric kettle has additional forward-looking causal powers that are not individuative of *Boiling Kettle*, such as the property that when the water in *Electric Kettle* boils the shape of the opening from which the steam rises makes a whistling sound to alert the user that the water is boiling. Finally, the backward-looking causal powers of *Electric Kettle* are a subset of the backward-looking looking causal

powers of *Boiling Kettle.* I have not included additional backward-looking causal powers in Figure 7, but an example of an additional backward-looking property of *Boiling Kettle* that *Electric Kettle* does not posses is that *Boiling Kettle's* backward-looking causal property 'heat' can be the result of burning wood, whereas *Electric Kettle* cannot be heated over a wood fire. The main thrust of this initial example is to describe the relationship between the causal powers of a property and its realizer. A realizer has a larger set of forward-looking causal powers, a realized property has a larger set of backward-looking causal properties. Another feature I would like to call attention to is that the kinds being realized are more general or abstract than the kinds that realize them. Shoemaker calls attention to this by pointing out that the higher-level properties will sometimes be determinables that are realized by determinates.[29] (Shoemaker 2007, 22-23)

This example might seem somewhat contrived to the reader. Rather than accepting that *Electric Kettle* realizes *Boiling Kettle* one could reasonably think that a better account would point out that the water molecules possessing a certain amount of kinetic energy realizes the boiling water in the kettle. The stipulated causal powers of the property I labelled *Boiling Kettle* could be better described as an instance of boiling water. And what realizes the boiling water is the physical state-of-affairs made up of the relevant water molecules having the right average mean kinetic energy when they are heated to 100ºC. This concern speaks against the general notion that properties are realized by other properties, and implicitly suggests that an account where properties are realized by states of affairs is preferable.[30] Shoemaker's account makes room for the realization of properties by states of affairs, and I address the way that his account describes the realization of a property by a state-of-affairs in §2.1.2.

The concern that the realization of a property by another property is misguided applies to descriptions of potential cases of multiple realization. Multiple ways of causing

[29] In my third and fourth chapters the role or place of abstract kinds will become important to assessments of multiple realization. In §3.2.4., I discuss an objection against some instances of multiple realization by Polger and Shapiro (2016) that they call 'Abstraction and Idealization'. That Shoemaker's account of realization acknowledges the explanatory role of abstract kinds and accords them a place in the hierarchy of properties he advances is a positive aspect of his account. I discuss the ontological status of abstracta in §3.2.4. in the third chapter, and §4.2. in the fourth chapter.

[30] This challenge comes up in a more pointed way when I discuss Carl Gillett's (2002; 2003) argument against 'flat' accounts of realization in §2.2.2. Gillett points out that any account of realization must allow for macroscopic properties to be realized by micro-entities that do not possess those properties.

the same outcome, that is to say multiple causation, is not the same as multiple realization, so care must be taken not to conflate different *causes* of a higher-level property with different *realizations* of a higher-level property, nor to assume that different causes of lower-level properties indicates that there are multiple different lower-level properties. This problem is unavoidable for an account that defines properties in terms of their causal powers, but that should not count as a fatal strike against such views. What is important to keep in mind is that a realizer is present simultaneously with the property it realizes; as long as the realized property is present, so is its realizer, whereas a cause precedes the instance of a property of which it is a cause. In the case illustrated by Figure 7, the property of bringing water to a boil is realized by the electric kettle when the kettle is plugged in, filled with water, and turned on for the period of time necessary to heat the water to its boiling point. The properties *Boiling Kettle* and *Electric Kettle* are co-temporal, whereas, the heating of the water by the electrical element causes, and thus precedes, the boiling of the water. In §2.1.3. I describe a case of multiple realization, as opposed to the simple example of realization illustrated in Fig. 7, that also conforms to Shoemaker's account.

The idea that properties are realized by states of affairs, such as the case where boiling water is realized by the relevant water molecules possessing a certain average kinetic energy, has a place in Shoemaker's view. He begins by discussing how one property can be the realizer of another, but recognizes that properties must, ultimately, be realized by states of affairs in the world. So, properties are realized both by other properties, and by states of affairs. This view allows Shoemaker's account to establish itself as a genuinely physicalist account of realized kinds, as I describe in §2.1.2. In §2.3 I describe how empirical evidence can be brought to bear on questions of multiple realization without conflating multiple causation with multiple realization. Finally, acknowledging that realized kinds have two types of realizers, properties and states of affairs, foreshadows a worry about over-determination that the causal exclusion argument raises. I address this in §2.1.4.

2. 1. 2. Shoemaker's account supports physicalism

The first desideratum, (1) the realization relation should support physicalism, is widely agreed upon. Shoemaker's account meets this desideratum in a straightforward manner. His account focuses on the causal powers of properties. If properties are characterized by their causal powers, there is little room for anything that won't count as physical. But more can be said about how Shoemaker's account connects the causal powers individuative of a realized property to the realizing property (or properties). In particular, it is worth describing how Shoemaker's account connects the causal powers individuative of properties to the physical material that makes up the objects that are the bearers of those properties. To illustrate how Shoemaker's account achieves this I review his description of states of affairs and how states of affairs realize properties.

Recall, from the previous chapter §1.3.1., Morris's requirement that an account of realization should explain *why* the realization of a property is necessitated by the physical facts about the world. Shoemaker uses states of affairs to describe the world and how properties are distributed. In doing so, he points to a way of explaining why particular properties are present when certain states of affairs obtain. To explain how, Shoemaker introduces a different kind of realization from subset realization, that he calls 'microphysical realization' or 'microrealization'. States of affairs are constituted by microphysical entities (micro-entities). These micro-entities have certain micro-properties. Shoemaker explains how, on his account, states of affairs, constituted by micro-entities, realize properties:

> The instantiation of a realizer of a property should be sufficient for the instantiation of that property, and no property of a micro-entity that is a part of a thing is such that its instantiation is sufficient for the instantiation of any of the properties of that thing. What is true is that the instantiation of a property of a micro-entity can be part of the state of affairs that is sufficient for the instantiation of a property of a macroscopic entity. What we have here is the realization of a property instantiation, not by another property instantiation, but by a microphysical state of affairs involving the instantiation of micro-properties in micro-entities.[31] (Shoemaker 2007, 32)

[31] Shoemaker's characterization of microphysical realization foreshadows Gillett's concern regarding flat and dimensioned account of realization. I expand on Shoemaker's comments to provide a reply to Gillett's objection to in §2.2.2.

The description of properties being realized by states of affairs grounds the presence of properties in physical states of the world. It also suggests a hierarchical view where properties are realized by other, lower-level, properties, which are ultimately realized by states of affairs.

Given the importance of states of affairs in meeting the first desideratum, I review some of the details of how, on Shoemaker's account, states of affairs realize properties. States of affairs are divided into two sub-categories: concrete states of affairs and existential states of affairs. Concrete states of affairs are "particular micro-entities having certain properties being configured in a certain way" (*Ibid*, 34). A concrete state of affairs includes the particular micro-entities that constitute the physical state, as well as the relations those micro-entities stand in to each other. The concrete state of affairs is the physically present micro-entities that constitute an entity that exhibits the relevant property. Existential states of affairs are more abstractly characterized compared to concrete states of affairs. Existential states of affairs are divided into positive and negative parts. The positive part of the existential state of affairs captures the requirement that there are other background facts about the world necessary for a property to occur.[32] The negative part of the existential state of affairs acknowledges that not only must it be the case that other properties, and the micro-entities that constitute them, must be present to realize a given property, but it must also be true that other properties (and their constituent micro-entities) are not present for the realization of a property.

To illustrate how these concepts operate, consider the background conditions necessary for an electric kettle to boil water. The concrete state-of-affairs that realizes my kettle and the water contained therein will realize the property *Electric Kettle* by including the micro-entities needed to make up the heating element (metals that have a particular electrical resistance) that will produce heat, the water molecules that behave in the relevant ways when exposed to that heat, and the materials that make up a container to keep the water from spilling and in contact with the source of heat. The positive

[32] Shoemaker describes the role of positive existential states of affairs as follows, "The positive part of the existential state of affairs will consists in its being the case that there are, appropriately related to that concrete state of affairs, other microphysical states of affairs that are realizers of instances of a number of other properties, each of these being one of the kinds that a thing of the relevant sort must exemplify." (Shoemaker 2007, 38)

aspects of the existential state of affairs includes, for example, the flow of electricity from the power grid through the outlet in my kitchen into the kettle so that the heating element in the kettle has a supply of electrical energy it can convert to heat. An example of the negative state of affairs necessary to bring the water to boil is that the atmospheric pressure in my kitchen is low enough that the heating element powered by my kitchen outlet can produce enough energy to bring the water to its boiling point.

So, according to Shoemaker's account of realization, properties are realized by other properties. Those properties are themselves realized by the occurrence of concrete states of affairs that are constituted by microphysical entities. The explanation for how those micro-entities, when they are found in appropriate conditions, are able to manifest the relevant causal powers, is left to the appropriate sciences. When a property is realized, it is because the relevant micro-entities are present to be the bearers of that property. The realization of a property involves not only the necessary positive states of affairs, but also an absence of other states of affairs, i.e. negative states of affairs, that would prevent the occurrence of that property. The realizers of properties are all entities that ought to be acceptable to physicalists, so Shoemaker's account of realization shows why realized properties are acceptable in a physicalist ontology.

2. 1. 3. Shoemaker's account is compatible with empirically discovered multiple realization

My second desideratum requires of an account of realization that it allow for the possibility of empirically discoverable instances of multiple realization. To illustrate how Shoemaker's account allows for this possibility I begin by describing how his account differs from identity theory. A property and its realizer(s) are not identical because a realized property does not have the same causal profile as its realizer. Shoemaker notes that subset realization clearly differentiates itself from identity theory:

> If the forward-looking causal features of a realized property are a subset of the forward-looking causal features of its realizers, it stands to reason that the causal powers of an instance of the realized property will be a subset of the causal powers of the instance of the property that it realized on that occasion. But of course, if the causal powers of one property instance are a proper subset of those of another, the instances cannot be

> identical. And if the instances are not identical we can dismiss the argument from their identity to the causal impotence of the realized property. So I favor the way of viewing second-order properties according to which the instances of second-order properties are not identical with instances of their first-order realizers, and, what goes with this, second-order properties have causal profiles of their own, distinct from, although of course intimately related to, the causal profiles of their realizers. (*Ibid*, 17)

The causal powers of a property are a proper subset of the realizing property's forward-looking causal powers and the realizing properties backward-looking causal powers are a proper subset of the backward-looking causal powers of the realized property, which guarantees that a property and its realizer cannot be identical, but it does not necessarily imply that properties are multiply realized. For example, suppose that the property of hardness, as measured by the Mohs scale, has exactly one kind of entity that is the hardest, diamonds, and one kind of thing that is the second hardest, glass.[33] The first-order realizer of a diamond's property of scratching glass are the carbon atoms, bonded in the requisite manner, that make up the diamond. That microphysical state of affairs also has other particular properties, such as a specific weight and a specific refraction index. So the property of having a certain hardness is a subset of the properties of the microphysical entities that realize the diamond. The property of having the highest hardness on the Mohs scale is possessed by a single kind, it is not multiply realized. But the property of having that hardness is not identical to its realizer.

Many realized properties require a complex set of conditions (concrete and existential states of affairs) to be realized, and some of these complex sets of conditions produce constraints that mean that those properties will be realized by a single kind of state of affairs, as Shapiro (2004) argues. In those cases, a property has a unique realizer. Shoemaker's account of realization allows that some properties might have unique kinds as their realizers. But his account leaves room for the possibility that it might also turn out that some properties can be realized by more than one different kind of state of affairs. This flexibility cannot be matched by traditional versions of identity theory that postulate that every property has a single realizing kind. On Shoemaker's account both

[33] The Mohs scale is used to describe the hardness of various rocks and other minerals. Kinds that are higher on the Mohs scale are capable of scratching kinds that are lower on the scale.

unique realizers and multiple realizers of a property are possible. In either case, the realizer(s) will be discovered only by empirical investigation.

Considerations regarding the surrounding conditions necessary for the realization of a property are reflected in functionalist accounts of mental kinds. According to functional accounts of mental kinds, those kinds are embedded in a complex set of other interacting properties. For any particular mental property there are a number of other related mental properties that are appropriately related to the property in question. This kind of interconnectedness is reflected in Shoemaker's description of the role of existential states of affairs. The realization of many particular mental properties requires the realization of a number of other mental properties as well, and consequently the realization of a particular mental property will involve the states of affairs that realize all the relevantly connected mental properties. The way that a mental property is embedded in a system constrains the way that it could be multiply realized, since its realization requires the realization of many connected properties (and states of affairs).

Shoemaker's account deals with the interrelatedness of mental properties by distinguishing a total realizer from the core realizer of a property. A realizer should guarantee the presence of the property that it realizes, so many states of affairs will have to obtain to realize any given instance of a property. This requirement is captured by invoking the idea of a total realizer. Total realizers include a large amount of peripheral factors that are necessary for the realization of a property, but that include states of affairs which overlap with the realization of many other properties. The total realizer is contrasted with a subset of those states of affairs, called the core realizer of a property (Shoemaker 2007, 37-38). Distinguishing a total realizer from the core realizer of a property is a way of acknowledging the complex system in which many properties are embedded. Shoemaker provides a straightforward example to illustrate the way that an instantiation of one property requires other properties to be co-instantiated with it: the example is simply the property of being a particular height (*Ibid*, 37-38, 41-43). To be a particular height a person or building must also have a particular width and depth. The core realizer will be the state of affairs that guarantees that the building or person possesses the relevant height, but that core will also be a part of the total realizer that

guarantees that the entity possesses a depth and width. Likewise, the property of being a particular width or depth will require that an entity have some height. So the total realizer of being a particular depth and a particular width will also involve being a particular height. The core realizers of some entity having a certain height, a certain width, and a certain depth, will overlap, but we can nevertheless distinguish the core realizer of each property from the core realizers of the other two properties.

I raise the distinction between core and total realizers in the context of discussing empirically discoverable multiple realization because there are two different ways cases of multiple realization could occur, depending on whether one focuses on differences among core or total realizers. First, a property might only have a single total realizer, but multiple kinds of core realizers. In the fourth chapter, §4.1. and §4.2., I present examples of multiple realization from research into language lateralization and reading acquisition that focus on how variation within a system can be approached as a case of multiple realization. To illustrate the general form of this kind of case, suppose that there are two core realizers, but that either core realizer also requires the presence of the other kind of core realizer as part of its total realizer.[34] The different core realizers would distinguish the way that the property in question is realized, but if one were to look at the total realizer, the property in question has the same state of affairs as its total realizer. Systems where there is redundancy of a particular sub-component in that system are places where this type of multiple realization could be found.[35]

The second way a case of multiple realization could occur is if the total realizers of a property are completely distinct. This kind of case requires that the two distinct total realizers with all the relevant causal powers of the property in question be instantiated. For this to be, the cases would need to be existential states of affairs that include the necessary relational properties individuative of the property in question. For a property to be multiply realized in this manner, two or more distinct complex systems would need to

[34] Shoemaker describes this in detail and emphasizes that this will include both forward-looking and backward-looking requirements on the causal powers that the states of affairs possess (Shoemaker, 2007, 42).

[35] Figdor (2010) explores this kind of potential for discovering cases of multiple realization. In the fourth chapter, §4.2., I present a case of this kind by describing how there are individual differences in language lateralization.

be instantiated. The difference between cases of the first kind and cases of the second will not be absolute; they will differ as a matter of degree. How much of an overlap there is between two systems that could realize the same property will be a matter of investigating, decomposing, and understanding how those systems work.

The way that systems are grouped together or distinguished illustrates the way that questions regarding whether a property has multiple realizers must be decided on empirical grounds. Investigation into these kinds of systems to understand what kinds of components are capable of playing the relevant causal roles is a central aspect of mechanistic explanations.[36] Only once the systems, and the states of affairs that realize them, are understood in terms of the sets of causal powers they realize, can any decision on whether a property is or is not multiply realized be made. Shoemaker's account of realization offers clear guidelines for deciding whether a property has multiple realizers, and to show that cases of multiple realization meet those constraints requires empirical evidence.[37] The realization of a property depends on the existential states of affairs that the different realizers require, which act as constraints on the possible ways a property can be realized. Some properties may be constrained in such a way that there is only a single kind of realizer for those properties. Determining whether a property has multiple realizers is a matter of empirical investigation for Shoemaker's account, so his account meets the second desideratum.

2. 1. 4. Shoemaker's response to the causal exclusion argument

I have two goals in this section. First, I show how Shoemaker's account meets the third desideratum (that an account of realization should avoid the causal exclusion problem). Second, I show that the way it avoids the causal exclusion problem does not result in an incompatibility with also meeting the second desideratum (recall in the previous chapter, §1.3.2. that this was the concern Pernu raised against some accounts of realization). Shoemaker's solution is to deny that the causal powers of a realized property are not

[36] Carl Craver's (2007) description of the role of mechanistic explanation in psychology, cognitive science, and neuroscience offers one framework to illustrate how empirical evidence is used to explain how components of a system interact to produce a phenomenon of interest.

[37] Shoemaker makes the point that whether certain properties count as being sufficiently unified to be useful in scientific explanation is an empirical question (Shoemaker 2007, 51).

duplicated by the causal powers of its realizer. This solution can be described as denying inter-level causation.[38] In §2.3. I return to the question of what denying inter-level causation involves. At present I note that denying inter-level causation does not amount to being an eliminitivist regarding functional or other second-order properties.

On Shoemaker's account the set of forward-looking causal powers individuative of a mental property are a proper subset of the powers of the property that realizes it; no new entities are added when realized properties are distinguished from their realizers. As he observes,

> The fact that every case of property realization is also a case of microphysical realization does not of course involve any sort of overdetermination, for in a physicalist world a property's instance's having a property realizer and its having a microphysical state of affairs realizer are one and the same thing. (Shoemaker 2007, 54)

Treating a property and its realizer as duplicating causal powers does not capture the relationship between a property and its realizer, and nor does the realizer simply supplant the causal powers of the property that it realizes. Shoemaker's account does not involve repetition of causal powers, the over-determination horn of the dilemma the causal exclusion poses to accounts of realization, because states of affairs are, at bottom, the realizers of properties, and states of affairs are not extra causes of other properties. The other horn of the dilemma the causal exclusion problem raises for accounts of realization is that realized kinds have no causal powers of their own, so there is no reason to posit them in explanations of any kind.

To show how realized kinds retain causal and explanatory relevance on

[38] Paul Pietroski (2000) considers denying inter-level causation as a way of avoiding the causal exclusion argument: "Within any one explanatory framework, we expect extra causes to be associated with extra effects. . . . But if a single effect has causes that belong to different explanatory frameworks (like bodily motion with mental and neural causes), this kind of overdetermination will not be associated with extra effects in any framework. One might summarize the point by saying that *intra*-level overdetermination is problematic in a way that *inter-level* overdetermination is not. (Of course, one is not entitled to say this straight off, without begging the question against neuralists; one needs to defend a conception of causation that allows for inter-level overdetermination.) Alternatively, one might apply 'overdetermination' to only the intralevel cases; but then event dualism will not have the consequence that bodily motions with mental causes count as overdetermined." (Pietroski 2000, 243-244) He offers this solution in defence of event dualism, an account he advances to explain mental causation. I do not wish to suggest that Shoemaker's view of realization shares many other features or consequences with Pietroski's account. I do, however, think it is worth noting that the solution to the causal exclusion problem I advance here has been defended in other contexts.

Shoemaker's account, I take a brief detour to summarize a conceptual tool Shoemaker uses in his response to the causal exclusion argument: microphysical-state-embedding-properties (MSE-properties). MSE-properties are introduced as a kind of intermediary between the realization of a property by another property, and the realization of a property by a state of affairs. A MSE-property is, at first gloss, the property of having a particular state of affairs as a realizer. MSE-properties are a kind of first-order property (Shoemaker sometimes refers to first-order properties as self-constituting properties), whereas mental properties are second-order properties. MSE-properties are properties of macrophysical entities that describe the historical composition of those entities:

> For any type of microphysical state of affairs that can realize an instance of a particular macrophysical property, there is a property something has just in case its career includes a microphysical state of affairs of that type that realizes an instance of that property. Let's speak of these properties of macroscopic entities that embed microphysical states of affairs that are property instance realizers – call them microphysical-state-of-affairs-embedding properties, or MSE-properties. If a property is such that an instance of it can be realized in a microphysical state of affairs of a certain type, then the corresponding MSE-property will be among its possible property-realizers. Assuming physicalism, mental properties will have such properties as realizers. (Shoemaker, 2007, 49-50)

MSE-properties specify which state of affairs is the realizer of a higher-level property. As such, they are not themselves realized by other properties; they are first-order properties, or as Shoemaker says, they are 'self-constituted properties' (Shoemaker 2007, 52).

Despite being first-order, or self-constituted, properties, MSE-properties are very limited in the roles they can play in scientific explanations. MSE-properties occur only briefly, rarely reoccur (and it would likely be a coincidence if one were to reoccur), and are very complex (specifying an MSE-property involves a description of all the constituent entities that make up the relevant microphysical state of affairs, concrete and existential, that realize the relevant property). MSE-properties will not figure into generalizations because they are too specific, particular, and unique.[39] So, MSE-properties

[39] Shoemaker puts this point as follows, “The idea that only self-constituted properties, properties that are not realized by other properties, do causal work, and that these preempt any causal efficacy we might be inclined to attribute to properties they realize, becomes unattractive when it is seen that there is no hope of our being able to refer to [them].” Shoemaker 2007, 52.

cannot supplant the properties they realize for explanatory purposes. In contrast to MSE-properties, the causal profiles of higher-level properties are distinctive because they figure into generalizations. In Chapter 4, §4.1. and §4.2., I touch upon the issue of how mental kinds, physical kinds, and scientific kinds, are to be individuated. I adopt an account of scientific kinds defended by Muhammad Ali Khalidi (2013). At present, I simply note that higher-level properties are not excluded or obviated by their lower-level realizers on Shoemaker's account.

Neither of the two horns of the causal exclusion dilemma applies to Shoemaker's account of realization, so his account meets the third desideratum, that an account of realization should avoid the causal exclusion problem. To do so, I said that Shoemaker's account denies inter-level causation. I conclude this section by explaining what this means for Shoemaker's account.

Recall the diagram of causal exclusion, Figure 1, from the introduction, §1.2.3, and its contrast with Figure 4, from §1.3.2. In the context of Shoemaker's account, the following diagrams illustrate possible interpretations of the realization of a mental property by a MSE-property:

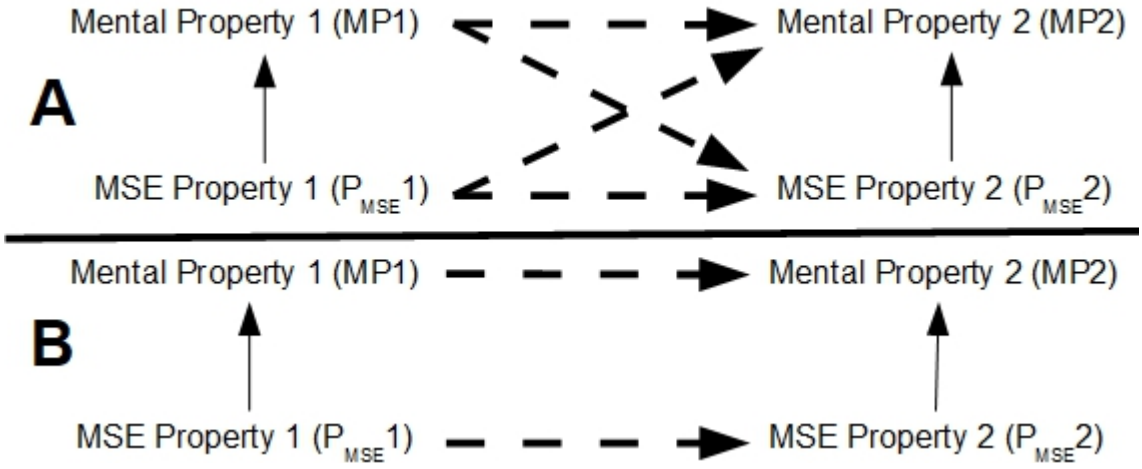

Figure 8: MSE property realization diagram. Figure 8A shows MSE property realization with inter-level causation. Figure 8B shows MSE property realization without inter-level causation. The solid arrows represent the realization relation. The dashed arrows represent causal relations.

The diagram at the top of Figure 8 represents an account of realization where there is inter-level causation. The diagram at the bottom represents the case where there is no

inter-level causation. I claim that Shoemaker's account is better represented by the diagram at the bottom of Figure 8. This is because the MSE-properties should be understood as causing other microphysical states of affairs to occur, rather than as causing the occurrence of other properties realized by those microphysical states of affairs. The causal powers of higher-level properties will not involve bringing about particular states of affairs; at best those powers will cause *kinds* of states of affairs. The causal powers of higher-level properties are not equivalent to the causal powers of their MSE-property realizers. Given that the causal powers of properties and their realizers are distinct and reference different kinds, MSE-properties will talk about states of affairs whereas realized kinds will refer to more general or abstract kinds, powers, or properties. In §2.2.2. I present an objection by Carl Gillett to certain accounts of realization that illustrates this difference. His argument focuses on ways that emergent properties are realized. I discuss his objection to flat accounts of realization and revisit the reasons to deny inter-level causation. In §2.3. I defend denying inter-level causation more generally.

2. 2. Objections to subset accounts of realization

In this section I present two objections against Shoemaker's subset account of realization. I address these arguments since if they are correct they would show that Shoemaker's account does not meet the desiderata I have defended. More generally, if these objections are correct, then it may be that the desiderata I advance cannot actually be met. To address this concern I respond to these arguments by showing how Shoemaker's account resists these objections.

2. 2. 1. Francescotti's objection to subset accounts of realization

Francescotti objects that subset accounts of realization have the potential to reverse the normal direction of the realization relation. Which is to say that mental properties could be the realizers of physical properties. If mental properties are possible realizers of physical properties, then realization cannot ground physicalism. In fact, if an account of realization allows for mental properties to act as the realizers of physical properties, then such an account would be advancing an ontology that is not just incompatible with

physicalism, but that is the inverse of physicalism.[40]

Francescotti's main concern is that physicalism cannot be adequately stated through the use of the concept of realization. This is not quite the same as claiming that the realization relation should support, or be compatible with, physicalism. To be able to advance and defend a version of physicalism based on realization is a more demanding task. One might reasonably think that realization is an important and useful notion whether or not it grounds physicalism. The truth of physicalism and how it is to be defined is a separate problem from the challenge of providing an account of realization, nevertheless I accept that Francescotti's argument reveals an important constraint on any account of realization. An account of realization should at least make it clear why physical states have a kind of ontological priority over mental states, i.e., why we think that physical states are realizers of mental states, but not vice versa. He presents this concern by arguing that Shoemaker's account of realization is inadequate for capturing the view that mental properties (and higher-level properties in general) occur solely in virtue of the physical facts about the world. The general concern Francescotti presents is that realization should put mental and physical properties in an asymmetric relation. Mental properties are realized by physical properties, but not *vice versa.* Francescotti specifically targets Melnyk's (2003) account of realization, but he groups Shoemaker's subset account with Melnyk's view.

Francescotti presents a general account of realization where properties are the realizers of functional roles:

> property G realizes property F (or token x of G realizes token y of F) for individual z at time t $=_{df}$ there is a functional role, R, characteristic of F, and G (or token x of G) plays role R for z at t.

[40] Francescotti's goal is to demonstrate why physical kinds have an ontologically prior place relative to mental kinds. His worry is that accounts of realization, such as the one advanced by Shoemaker, cannot maintain this type of ontological hierarchy. “The fact that there are cases in which the phenomena of physics are realized [according to the views of realization Francescotti is critiquing] by mental phenomena would seem to undermine the prospect of characterizing Physicalism in terms of realization. Physicalists believe that all phenomena occur solely in virtue of physical phenomena. But if a mental token can realize a physical token, then it seems whatever makes it the case that mentality obtains in virtue of physical phenomena, it is not simply that the former is realized by the latter.” (Francescotti 2010, 607) Francescotti considers several ways that the ontological asymmetry between the mental and the physical might be preserved by accounts of realization, but rejects them as inadequate (*Ibid*, 611-13).

Melnyk's account is a more precise version of the general account presented above. It involves three clauses:

> [RP-R] Token *x* realizes token *y* (or: token *y* is *realized by* token *x*) iff
> 1. *y* is a token of some *functional* type F (i.e., some type whose tokening just is the tokening of some or other type that meets a certain condition, C);
> 2. *x* is a token of some type that in fact meets C; and
> 3. the token of F whose existence is necessitated (in the strongest sense) by the holding of clause (ii) is numerically identical with *y.* (Melnyk 2006, 129 quoted by Francescotti 2010, 603)[41]

This definition of realization ties the instantiation of a functional type to there being a token that meets the conditions for counting as that type. What that condition or those conditions are is not specified, but for our purposes we can suppose that the condition, C, can be a causal profile in keeping with Shoemaker's characterization of properties. Francescotti notes specifically that Shoemaker's account of realization is captured by this general account, and so is open to the following objection he raises against Melnyk.

Francescotti objects that they do not adequately prioritize the physical; mental states could be realizers of physical states. The objection proceeds as follows,

> OP1: Assuming substance dualism is false, every sentient being has a body,
> OP2: A body is a token of a type of physical object, namely objects with density,
> OP3: Being sentient is a mental property,
> OP4: A token of a sentient being necessitates that there be a body,
> OC: So, there are mental types whose instantiation necessitates physical tokens of a certain type.[42]

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[41] Francescotti makes the following comment following the presentation of Melnyk's account of realization, "The lack of a token-identity claim allows us to believe that mental events are realized by physical events and also that organisms with mental features are realized by physical bodies, while remaining neutral on the difficult issue of whether *constitution* counts as identity (e.g., whether the mental event is identical with the constituent neural event, or whether the person with mental properties is identical with the constituent body)." (Francescotti, 2010, p. 603) This comment highlights the challenge in differentiating the realization relation from identity. I claimed earlier in the paper that constitution was a weaker condition, as it required only sufficiency, whereas identity would require both necessity and sufficiency. Francescotti presents this kind of idea using slightly different language, "In fact, if Melnyk is correct, not even *tokens* of higher-level functional types need to be identical with tokens of physical types; thanks to condition (iii) of [R], the realizer token necessitates, but need not be identical with the token that is realized." (*Ibid*, p. 604) The claim that a realizer token necessitates the token that is realized does not result in any relevant practical differences with my claim that the realizer token is sufficient for the realized token.

[42] This is an abbreviated version of the argument by Francescotti (2010, p.605) where he carefully

The argument applies not only to density but to many physical properties. It is also possible to substitute many different mental properties for sentience, such as perceiving a particular shade of red, or believing that it is likely to rain later today.[43] Francescotti concludes that if mental states are able to be the realizers of physical states, then the concept of realization will not be able to help ground physicalism.[44] Francescotti notes that Shoemaker's account of realization is subject to the same type of criticism he raises against Melnyk,

> Regarding Shoemaker's account: the conditional powers (e.g., the potential behavioral consequences) of *perceiving an approaching lion* or *believing that one is being stalked by a killer* seem to be at least as numerous as the conditional powers of *occupying space* or *having density*, or various other general physical properties – especially if having the mental property guarantees having those general physical properties. (*Ibid*, p. 610)

Francescotti is drawing on the fact that on Shoemaker's account of realization a realized property must have a total realizer, and the total realizer of a property includes positive concrete states of affairs. So a realized property will guarantee that there exist certain kinds of physical states of affairs, which seems to reverse the intuitive dependence that should hold between a realizer and the property it realizes. In this manner Francescotti calls into question the ability of Shoemaker's account to meet the first desideratum I defend.

The challenge raised by Francescotti for Shoemaker is that an account of realization should give priority to physical properties; mental properties should not be able to act as realizers of physical properties in the same manner that physical properties

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illustrates how all three of Melnyk's conditions on realization are met.

[43] Francescotti bases this claim on particular localization claims, such as "the human color center is to be located in the fusiform gyrus of human visual area V4, the ventral occipitotemporal cortex" (*Ibid*, p.606). While these claims are based on the logic of localization, we do not need to accept localization claims for his argument to be effective. Whether a mental state is localized to a specific brain region, or if we think that such states require activation across many brain areas to form a particular network, or even if we think that such states require fully embodied descriptions, the point that the mental state necessitates some physical state remains true, it is just unclear which physical state will be necessitated.

[44] Another threat that is raised by this kind of argument is that it may show that the realization relation collapses back into an identity relation. Pernu notes the possibility of such a result, "Hence the presence of the supervenient properties necessitate the presence of their realizers and the presence of the realizers necessitate the presence of the supervenient properties. What this seems to amount to, in effect, is that mental properties and their realizers are identical." (Pernu, 2014, p. 527b.)

count as realizers of mental properties. Shoemaker acknowledges the importance of physicalism to accounts of realization during his description of microrealization. In presenting his account of microrealization Shoemaker states,

> I assume here a physicalist view according to which all of the facts about the world are constitutively determined by the microphysical facts – facts about the properties of basic physical entities and how they are distributed in the world. (Shoemaker 2007, 33)

Shoemaker is clear that his account of realization will not explain why microphysical entities have the properties that they do. This caveat concedes to Francescotti his point that Shoemaker's account of realization will not ultimately explain why physicalism should be accepted. However, arguments for the acceptance of physicalism stand separately from the way that an account of realization can be compatible with physicalism. So long as there are independent reasons for accepting physicalism, which I think there are, only the latter is required of an account of realization.

To reply to Francescotti then, I take my task to be to illustrate how microrealization establishes the proper asymmetry between mental properties and physical properties. So Shoemaker's account should have the result that microphysical properties are good candidates to be realizers of mental properties, but that the reverse does not hold.

To show how Shoemaker establishes an asymmetry between mental properties and physical properties I draw upon the concepts of core and total realizers, and concrete and existential states of affairs. Recall that a total realizer is the state of affairs (concrete and existential) that is minimally sufficient for the realization of a property. There are, of course, states of affairs much more expansive than this minimal state of affairs that could also realize the particular property in which we are interested, but these more encompassing states will be of little interest (as they may be as inclusive as pointing out that the whole of time and every microphysical state across the universe realizes a particular property, but pointing this out will be to have said very little) (Shoemaker 2007, 34-5). Certain microphysical states (both positive and negative states of affairs) constitute a minimal state necessary to realize a particular property. Some of these minimal states of affairs contribute more directly to the realization of a given property than others. Those

which contribute directly constitute the core realizer, but there will be other states necessary for the instantiation of any property that is not self-constituted.

The other states necessary for the realization of a property in addition to the core realizer include existential states of affairs. Recall the example Shoemaker uses to illustrate the idea of existential states of affairs is of being a certain height (*Ibid*, pp. 43-44). In this example Shoemaker notes that for someone to be a particular height, they must also be a particular a width and depth. They must have these additional features because anything that exists with a height must also occupy space and have a volume. However, no particular width or depth is required to realize being a certain height. Nevertheless, for any particular state of affairs, there will be a *specific* width and a *specific* depth of the person in whose height we are interested. But by looking at the core realizer, we know only that there must *a* depth, and *a* width, for someone to be a certain height.[45]

With these distinctions in hand I can now explain why there is an asymmetry between mental properties and physical properties on Shoemaker's view. It is true that mental properties have, as part of the existential states of affairs that realize them, the kinds of properties Francescotti mentions in his argument, e.g., density or volume, but it will never be the case that a mental property has a concrete core with a specific density as its realizer. At best, it will be part of a total realizer that includes the microphysical state of affairs that realizes a particular density. Taking this into account, mental properties may necessitate kinds of physical states, but those kinds of physical states are substantially more general than Francescotti implied.[46] Mental properties entail the

[45] Shoemaker summarizes the interrelations of these concepts as follows, "The concrete state of affairs will be specific to the particular property whose instance is realized, and can be viewed as the "core" of the realization of the instance. The positive part of the existential state of affairs will consist in its being the case that there are, appropriately related to the state of affairs, other microphysical states of affairs that are realizers of instances of a number of properties, each of these properties being one of the kinds that a thing of the relevant sort must exemplify. This positive existential state of affairs will exist in virtue of there existing a number of states of affairs that are partly concrete, each of which will be a total realizer of one of the properties coinstantiated with the one in question. Each of these will have a different concrete core, and the concrete core of all of these property instances will make up the concrete part of a state of affairs that realizes the entire set of property instances." (Shoemaker, pp. 37-8)

[46] Shoemaker groups the kind of properties that require that there be some kind of state of affairs under the name "microphysical-state-of-affairs-embedding properties or MSE-properties" (*Ibid,* p. 50). He is sceptical that these kinds of properties will figure into scientific explanations of any sort. So, while these MSE-properties will be the kinds of properties by which a given instance of a mental state could be said

presence of physical states only because we have accepted the truth of physicalism (OP1 expresses the commitment to physicalism), but this does not mean mental states count as realizers of those physical states.

To illustrate what kinds of physical properties are entailed by mental properties on Shoemaker's account, consider the following example, I have the desire for a hot cup of tea. Such a desire is embedded in vast system of connected mental properties that allow it to possess the requisite causal powers, and both the desire and the related mental properties have microphysical-state-embedding properties. From this we can infer that whenever a desire for a cup of hot tea is realized, there will be a microphysical state with a mass that realizes the desire. But what will fix the mass of the microphysical state will only accidentally have to do with the realization of the desire. There will be many other ways that the relevant mass could be realized that have nothing at all to do with desiring hot tea. So the core realizer of the desire for hot tea will not count as being a core realizer of a particular mass. There is an asymmetry on Shoemaker's account between physical properties and mental properties (or more generally between self-constituted properties and second-order properties) that gives priority to physical properties and the microphysical states of affairs that realize those properties.

On Shoemaker's view mental properties have microphysical states as their realizers in virtue of that fact that mental properties have MSE-properties as their realizers. MSE-properties entail that a particular microphysical state of affairs is present, since this is the nature of a MSE-property. It is in their definition that they embed a particular microphysical state into the history of an entity. So the question then is whether MSE-properties are problematic or incompatible with physicalism. As I noted when I first summarized Shoemaker's account of MSE-properties, they are odd properties. They are not typically what we think of when we think of properties, nor are MSE-properties the kinds of properties that play a role in scientific theories or explanations. But nothing about MSE-properties is incompatible with physicalism. MSE-properties fit

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to realize a physical state, they would not grant any kind of primacy to mental states over physical states. Francescotti's objection that the existence of mental properties necessitates the presence of physical properties presupposes the truth of physicalism, and if physicalism is true then physical kinds already have the required ontological priority.

unproblematically into a physicalist ontology.

This leaves me with one final concern to address for Shoemaker's account of realization. How does such an account fit with the denial of inter-level causation? While discussing the causal exclusion problem I argued that realized properties did not duplicate causal powers of their realizers. Such a solution is problematic as it appears to rule out even the simplest cases of emergent properties. I now address this last objection to Shoemaker's subset account of realization, raised by Carl Gillett (2002; 2003).

2. 2. 2. Gillett's objection to flat accounts of realization

My aim in this section is to argue that Shoemaker's subset account of realization is able to incorporate the requirement, defended by Gillett (2002; 2003), that realization be dimensioned. Gillett distinguishes two types of realization accounts, 'flat' accounts (Gillett also refers to flat accounts as the Standard view) and 'dimensioned' accounts. Accounts of realization that are flat take the relata connected by realization to be found in the same individual. Shoemaker acknowledges that this is a core aspect of his account, calling that type of realization 'same subject realization' (Shoemaker 2007, 10). On flat accounts the realizer and realized property are present in the same subject and contribute the same causal powers. The two conditions Gillett (2002) presents as characteristic of a flat account of realization are,

> • (I) A property instance X realizes a property instance Y *only if* X and Y are instantiated in the same individual.
> . . .
> • (II) A property instance X realizes a property instance Y *only if* the causal powers individuative of the instance of Y match the causal powers contributed by the instance of X (and where X may contribute powers not individuative of Y).
> Through (I) and (II), the Flat view of realization earns its name by taking the realized and the realizer properties to share both the individual in which they are instantiated and at least some of the causal powers contributed to this individual. (Gillett 2002, 317-318)

Gillett summarizes what he takes to be the core of flat accounts as,

> Under the flat view, one property instance realizes another only if the realizing property contributes *all* the powers individuative of the realized property. - the realizer property instance thus literally plays the very causal

role that individuates the realized property. (Gillett 2003, 593)

A flat account of realization takes literally the notion that a realizer plays the causal role of the property that it realizes.

Shoemaker's subset account of realization appears on its surface to fit these conditions. On his account a realized property consists in a set of causal powers that are a subset of the causal powers possessed by its realizer, so the causal powers individuative of the realized property are contributed to the entity that possesses the property because those causal powers are part of the set of causal powers of the realizer. When speaking about same subject realization, it should be clear that Shoemaker accepts the features Gillett presents as characteristic of flat accounts. If this is all that there is to Shoemaker's account, his account would obviously be a flat account. However, we should be sceptical that Shoemaker accepts (I) on his detailed account. At the outset Shoemaker notes, ". . . I will argue later that all properties of macroscopic things that figure in our thought and discourse about them are realized in properties other than themselves." (Shoemaker 2007, 3.) But before I argue that Shoemaker's account is not in fact flat, I present the reasons Gillett has for rejecting flat accounts as viable accounts of realization.

In short, flat accounts of realization are inadequate, according to Gillett, because they cannot accommodate many common cases of realization. Specifically, flat accounts of realization do not allow for emergent properties. Examples of the kind of emergent properties that flat accounts cannot accommodate include the liquidity of water and the hardness of diamonds.[47] The latter is the example Gillett uses to show why flat accounts fail. A diamond is composed of carbon atoms that are bonded to each other in a complex crystal lattice structure. This results in diamonds possessing the property of being extremely hard, which in turn gives diamonds the power to scratch and cut glass. The figure below, *Figure 9*, illustrates a simplified case of a diamond that is composed from

[47] In speaking of the hardness of a diamond, I take Gillett to be discussing the kind of property or properties characterized using the Mohs scale (and other similar scales that measure macroscopic properties of materials). The Mohs scale rates the hardness of a material relative to other materials depending on which material is capable of visibly scratching another material. This is not quite the same property as the ability of one substance to penetrate another. Atoms of all kinds are very hard to penetrate (the language of penetrating an atom may even be taken as somewhat metaphorical), but this kind of impenetrability is not the same as the property of hardness relevant to the Mohs scale.

carbon atoms,

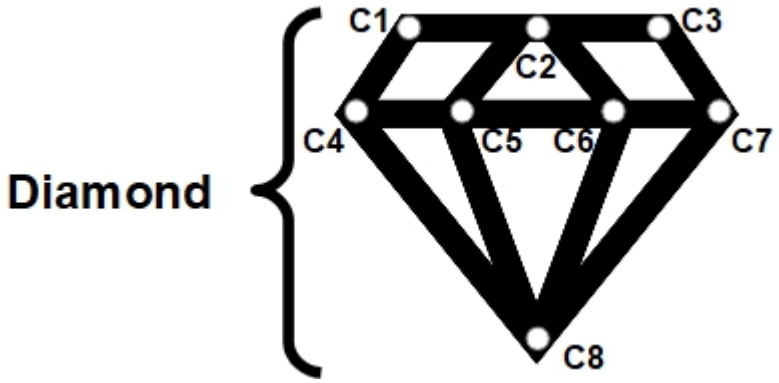

Figure 9: Dimensioned realization diagram. The diamond is composed of carbon atoms that are bonded together in a specific lattice structure. The carbon atoms are represented by the white dots labelled 'C1' to 'C8'.

However, none of the constituent parts of the diamond (the carbon atoms and their bonds) possess that property (the property of being hard enough to scratch glass). Gillett then observes,

> In this case it is clear that H [the property of hardness] is not identical to any of the particular properties/relations of any individual carbon atom, for H is instantiated in the diamond whilst particular relations of bonding and alignment are instantiated in some carbon atom. Furthermore, H contributes very different powers to *s** [a particular instance of a cut diamond] from the powers contributed by the relations of the alignment and bonding of the carbon atoms. For example, the former contributes the power to cut glass, whilst the latter contributes the power to cause a contiguous atom to remain in a tight relative spatial range. Given these differences, H cannot be identical to any of the particular properties/relations of the carbon atoms. (Gillett 2002, 319)

What Gillett has shown is that none of the constituent micro-entities that make up a diamond have the property of being hard. Gillett argues that constituents of an entity cannot contribute a property they do not themselves possess. Subset accounts of realization do not increase the number of causal powers in the world. A realized property will have only a subset of the forward-looking causal powers of its realizer. This leaves subset accounts of realization with the challenge of explaining how novel causal powers of macroscopic entities can be realized.

One might be tempted to accept that Gillett is correct that no individual atom or bond realizes the hardness, but respond that the property of hardness is realized by a

combination of atoms and bonds that form a structure which possess the relevant property. Hardness is a structural property that is realized by the relations that hold between the atoms that make up the diamond. Gillett points out that this response does not save flat accounts of realization. The instinct to try to save flat versions of realization by appealing to structural properties fails, according to Gillett, because it merely relocates the problem. The properties of atoms are themselves structural properties generated by sub-atomic particles. The properties of those sub-atomic particles are not identical to the properties of atoms, so the problem Gillett has raised for the realization of the hardness of a diamond by carbon atoms reoccurs, but in this case the properties of an atom are not shared by the sub-atomic components of the atom (Gillett 2002, 319-321). Sub-atomic particles do not contribute to an atom the necessary properties (sub-atomic particles do not have the property of, for example, having a certain number of bonding sites) whether those properties are ones possessed by the atom on its own or as relational properties. The properties of fundamental entities (whatever those may turn out to be) are not identical with the properties of macrophysical entities, so there is a mismatch that has the result that flat accounts of realization cannot treat the constituent micro-entities of a thing as the realizers of the properties of that thing. Micro-entities cannot contribute macroscopic properties to the entities they make up, since the micro-entities do not themselves possess those properties.

In place of flat accounts of realization Gillett proposes an alternative account he calls the dimensioned account of realization:

> Property/relation instance(s) F1-F*n* realize an instance of a property G, in an individual *s*, *if and only if s* has powers that are individuative of an instance of G in virtue of the powers contributed by F1-F*n* to *s* or *s*'s constituents, but not vice versa. (*Ibid*, 322)

This is Gillett's positive proposal for an account of realization that is meant to replace flawed flat accounts. The key difference is that constituents of an entity can contribute powers that do not match the powers individuative of the property being realized. So, the atoms that make up a diamond can contribute to the realization of the property of hardness without possessing that property themselves. As Gillett summarizes his view using the example of a diamond's (s*) power to cut glass (C*),

> The diamond s* thus has C* in virtue of the powers contributed by the relations of bonding and alignment, even though none of these relations themselves contributes the power C*. The properties/relations of the diamond's constituents thus 'play the causal role' of the realized property H in a wider sense, one *not* literally involving contributing H's individuative causal powers to any individual. (*Ibid*, 321)

The causal powers individuative of a property in these kinds of cases are not subsets of the causal powers of the realizers of that property, so the dimensioned account of realization allows for cases where macroscopic entities possess novel causal powers.

This, it turns out, is very similar to Shoemaker's full account of realization after all. By describing the example of a diamond's hardness I show how Gillett's objection misses its mark against Shoemaker's account. Call the general property of hardness, HARD, and property of hardness as realized by a diamond, $HARD_D$. HARD has the forward-looking causal power of scratching glass among its forward-looking causal powers and since a diamond has the property $HARD_D$, which includes the power to scratch glass among its forward-looking causal powers, then $HARD_D$ is a realizer of HARD. A particular diamond is made up of a particular set of micro-entities that compose that diamond, so the diamond has the MSE-property that embeds those micro-entities in the history of its existence. The instance of $HARD_D$ in question is realized by a series of MSE-properties that pick out the set of atoms that make up the particular diamond. HARD is realized by $HARD_D$ and the instance of $HARD_D$ is realized by the relevant diamond's MSE-property that situates the carbon atoms that compose the diamond into that diamond's causal history.

Shoemaker's account of microphysical realization is a detailed version of the claim that the constituents of an entity realize the properties of the instance of that thing. Shoemaker's description of the contributions made by states of affairs, both concrete and existential, to the realization of a property gives some details about how a state-of-affairs realizes a property. Going beyond this to analyze the metaphysics of how micro-properties can generate observable macro-properties that are distinct from any micro-property is far beyond the scope of this paper. What I do think is clear is that Shoemaker's account of microrealization fulfils the requirement on an account of realization that

Gillett has defended. Shoemaker's account does so by embracing the dimensioned version of realization Gillett defends. Microrealization is a dimensioned account of realization, as Shoemaker points out,

> To summarize, I have given an account of how instantiations of properties, both mental and non-mental, can be realized in microphysical states of affairs. This account allows instances of functional properties . . . and determinables to have microphysical realizers that are different from, although embedded in, the microphysical realizers of the instances of the physical properties (the determinate) that are their property-realizers. This allows instances of mental properties to cause the things we take them to cause, compatibly with these instances being physically realized. (Shoemaker 2007, 53)

This summary of how functional properties and physical properties are both realized by states of affairs that are made up of micro-entities illustrates why Shoemaker's account appears flat on its surface, but on a closer inspection of the details turns out to be dimensioned. A property is defined by its causal profile, so the realization of one property by another property whose causal profile includes as a subset the causal profile of the realized property leaves no room for novel causal powers to appear. This makes Shoemaker's account appear flat. However, there is a use for this type of analysis, as it highlights the core realizer of a property against the background of its total realizer. In contrast, when the realization of a property is presented by providing the state of affairs that realized the property, new causal powers are involved. The realized property is still specified in terms of its causal profile, but in the latter case the realizer is a state of affairs made up of micro-entities and not specified in terms of causal powers at all, making Shoemaker's account dimensioned.

One final point to note regarding the dimensioned requirement is that not everyone is in agreement that an account of realization ought to accommodate emergent properties. Morris has reservations about whether emergent properties are compatible with physicalism, “The problem is that it is doubtful that we should endorse a view of realization under which, for instance, emergent properties can be physically realized.” (Morris, 2007, 406) I am less pessimistic about the possibility of giving a plausible physicalist account that allows for emergent properties. As I have argued in this section,

Shoemaker's account of realization does so. It may be that what Morris means by "emergent" is narrower than what I take the term to designate. I, in agreement with Gillett, take emergent properties to be properties whose causal powers are not causal powers possessed by fundamental entities. Examples of emergent properties as I understand them are liquidity or hardness. However, Morris may have in mind only a more restricted kind of emergence where the appearance of special causal powers results from a high degree of complexity within a system. My discussion of emergent properties, following Gillett, focuses on the realization of emergent properties in a broad sense, such as hardness.

Given some of the features of an account of realization that Morris accepts, there is reason to think he should be willing to accept the manner in which Shoemaker's account accommodates emergent properties. Morris proposes the following as an example of an account of realization that meets his desideratum:

> *RZ3*: Realized properties are second-order relational properties. (M is a second-order property just in case for something to have M is for that entity to have some other property that stands in relations C.) P realizes M (or is a "realizer" of M) on some occasion just in case P stands in relations C. (*Ibid*, 412)

On this account a realized property is any property an entity has in virtue of possessing some other property. This way of characterizing realization shares two features with Shoemaker's account. First, Shoemaker describes a hierarchy of different kinds of properties. At the base of the hierarchy are self-constituted properties, which act as the realizers of other properties. This suggests that Shoemaker's account of property realization fits the scheme presented in RZ3. Second, Shoemaker provides a role for aspects of the world that are not part of the entity that exhibits the relevant property by contrasting the ideas of a total realizer and a core realizer. These aspects of Shoemaker's account accommodate emergent properties, and the manner by which they do so suggests a way of grounding emergent properties so they do not appear as being problematically mysterious.

2. 3. Inter-level causation

I return now to add some details about what I mean by my denial of inter-level causation as a solution to the causal exclusion problem. In §2.1.4., when I showed how Shoemaker's account avoids the causal exclusion problem, I concluded that the solution was to deny inter-level causation. A major challenge to analyzing what inter-level causation amounts to, and so what it means to deny it, is deciding how different levels are defined or individuated from one-another. Talk of different kinds of levels and how to distinguish them (both in terms of how to individuate levels within a single kind, and how one kind of level is distinguished from another kind) have been a recurring challenge for discussions in philosophy about levels in the sciences (see examples of discussions about levels in Wimsatt 2007; 1976). Some of the various different types of levels in science that are discussed include levels of explanation, existence, organization, function, and causation. Shoemaker's account involves accepting that there is a way of ordering properties. Self-constituted properties, including MSE-properties, are the lowest level of properties in this hierarchy, and the properties that are realized by self-constituted properties are second- or higher- order properties on his account. There are two kinds of levels that are relevant to this discussion, levels of properties and levels of causation.

The way that levels of properties are organized on Shoemaker's account makes it clear that some properties can be the causes of other properties, since a property is defined by its backward- and forward- looking causal profile. Properties are also the realizers of other properties, which is how levels of properties are ordered on his account. The discussion of Gillett's way of classifying accounts of realization as being either flat or dimensioned highlights the non-causal way that micro-entities which make up a macro-entity generate causal powers that are not possessed by the micro-entities. The causal powers of macro-entities are distinct from the causal powers of micro-entities, and this suggests that there is a way of distinguishing levels of causation on dimensioned accounts of realization. This line of reasoning also supports rejecting inter-level causation.

The argument Gillett raises against flat accounts of realization depends on there being emergent causal powers. If there are levels of causation, then it is reasonable to

suppose that emergent causal powers belong to a different level of causation from basic (non-emergent) causal powers. Emergent properties have causal profiles that include forward-looking and backward-looking powers that are not possessed by the micro-entities that constitute the macro-entity that possesses the emergent causal power. An emergent property will be individuated by powers that do not occur in the realizers. This supports my denial of inter-level causation. Emergent properties are not individuated by the same causal powers that are individuative of the state of affair realizers (MSE-properties) of the emergent properties.

A separate line of reasoning that supports rejecting inter-level causation comes from Craver and Bechtel (2007). Craver and Bechtel (2007) argue against the occurrence of inter-level causation in the context of mechanistic explanation. They deny that there is a need to appeal to inter-level causation when providing a mechanistic explanation of a phenomenon. Instead, the occurrence of a phenomenon can be explained by appealing two other relations, intra-level causation and constitution. Craver and Bechtel identify different levels of a mechanism using Craver's account of levels in mechanisms (2002; 2007). They proceed to argue that within a level of a mechanism we can sensibly discuss causal relations among the components of the mechanism found at that level, but talk of causal relations between components at one level of a mechanism and another does not add anything to a mechanistic explanation. Inter-level causal claims can be replaced with descriptions of causation among components at one level, and constitution relations that hold between components at different levels within a mechanism (Craver and Bechtel 2007, p. 561).

Felipe Romero (2015) extends the view presented by Craver and Bechtel and defends a way of understanding how interventionist accounts of causation can be made to be consistent with the denial of inter-level causation within mechanisms. Recall from the previous chapter, §1.3.2., I discussed Pernu's objection that avoiding causal exclusion and accepting multiple realization cannot both be achieved if you adopt an interventionist account of causation. Romero's argument shows that denying inter-level causation resolves this tension in the context of mechanistic explanations.[48] To briefly summarize

[48] There is some debate regarding the success of this strategy, as it depends on how one analyzes the

his argument, Romero proposes that in some cases different kinds of interventions are needed to identify the constituent components of a mechanism and the causal relations between those components. The manipulations of a mechanism that can be used to identify component membership of a mechanism will sometimes fail to be ideal, because such interventions affect many variables (the values used to quantify the entities and activities that make up the mechanism in question) simultaneously. These so-called 'fat-handed' interventions do not reveal causal interactions among the constituent entities of a mechanism, and so should not be interpreted as providing evidence of top-down causation within a mechanism.

By recognizing that fat-handed interventions result in changes to both a mechanism taken as a whole and to its components simultaneously, there is another way of describing the kinds of interventions that Pernu argues show the incompatibility of multiple realization with solutions to the causal exclusion problem. In supposed cases of multiple realization, as illustrated in Figure 2 and Figure 3 in the previous chapter, there are problem cases where an intervention on a physical property (PP1) will have no effect on the mental property (MP2) even though PP1 is a possible realizer of a mental property, MP1, and MP1 causes MP2. The problem arises when MP1 is realized by another physical property, PP1*. When this kind of case occurs (an intervention on PP1 fails to produce any change to MP2) this can be taken as evidence that PP1 was not the realizer of MP1. Intervening on the property involves intervening on the entity that possesses the property, and when such an intervention fails to produce a change in output under investigation, in this case MP2, there are two possible conclusions to be drawn. Either that the entity upon which there was an intervention is not causally connected with the output (MP2), or the attempted intervention on the property failed because the entity was not present and so there was no change to the measured property. To decide which of the

discovery of causal connections through ideal interventions. For example, Romero seeks to overcome challenges to the interventionist account of causation by adding the concept of fat-handed interventions to fill a gap in accounts that can appeal only to ideal interventions. Contrary to this, Totte Harinen (2014) argues that the concept of an ideal intervention has to be extended, but that doing so results in accepting there is inter-level causation within some mechanisms. I will not enter into the debate surrounding the analysis of ideal interventions to identify causal relations. I mention the debate for completeness's sake, but wish to highlight that at least some of the participants in this debate reject inter-level causation for different reasons than the ones I raise in this paper.

two kinds of case took place, a fat-handed intervention on the mental property (MP1) could be performed to discover whether PP1 (or the entity that possesses MP1) is changed. In the case where PP1 is not present or present but not the realizer of MP1 and the fat-handed intervention on MP1 results in a change in the value of MP2, then there is evidence that PP1 is not a component of the realizer of MP1.

If not all interventions reveal causal interactions, the challenge Pernu raises to the compatibility of multiple realization with a solution to the causal exclusion problem can be resolved. Both bottom-up and top-down interventions are needed to investigate a system, and it is only once both kinds of interventions have been studied that one can draw conclusions regarding the causal interactions within that system and the presence of components in that system which take part in those causal interactions. Some interventions produce evidence regarding the composition of a realizer rather than information about the causal interactions in which the realizer takes part.

Accepting that the solution to the challenge raised by Pernu is to deny inter-level causation comes with its own set of questions and challenges. The kinds of causal powers a property can have will not include any inter-level causal powers. On Shoemaker's account properties are individuated by their causal profiles, so this constraint will be reflected in the way that properties are individuated. Thinking about how different properties should be classified and what is distinctive of properties of the different kinds (beside functional properties Shoemaker discusses thick and thin properties) is a separate metaphysical challenge. An account of realization cannot be asked to settle questions about how to classify properties. Doing the conceptual analysis for various properties to clarify the ontological conditions for those properties is a different philosophical project than that of developing an account of realization. Gillett's requirement that an account of realization should include the realization of emergent properties is justified. Going beyond that to ask of an account of realization that it solves the kinds of metaphysical problems found in discussions of property ontology is too demanding.

Shoemaker's account of realization is dimensioned and so can account for the realization of emergent properties. It avoids the problem that it ought to, and that is enough. Shoemaker's account of realization serves as a proof of concept that the

desiderata I advance can be satisfied. As such, I take it that both the desiderata and his account can be deployed as needed throughout the remainder of my dissertation.

2. 4. Summary

In the previous chapter I presented and defended three desiderata for an account of realization:

1. The realization relation should support physicalism,
2. Multiple realization should be decided on empirical grounds,
3. The account of realization should avoid the causal exclusion problem.

I grounded the desiderata in the history of the use of the term "realization" and its connection to functionalism as a response to identity theory. I then considered and replied to objections raised by Kevin Morris and Tuomas Pernu to the desiderata. In this chapter I described how Shoemaker's account of realization meets all three of the desiderata, and argued that his account does so consistently. I then addressed two objections raised against Shoemaker's subset account of realization, by Robert Francescotti and Carl Gillett. I responded to both critiques. I concluded therefore that Shoemaker's account of realization is a viable account that meets the desiderata I defend.

I note some ways this result might impact future research. First, I wish to highlight an aspect of the second desiderata. I argued that whether any particular property is multiply realized is determined on the basis of empirically gathered evidence. Shoemaker's account allows for multiply realized properties, but it does not necessarily entail that any particular property is multiply realized. At no point did I provide any examples of particular cases of multiple realization. The number of actual cases of multiple realization in neuroscience has recently been called into question by several authors, starting with Bechtel and Mundale (1999) (see also: e.g., Polger, 2004; 2013; Shapiro, 2000; 2012; Polger and Shapiro 2016, and for defences of multiple realization see Aizawa and Gillett, 2009a; 2009b; 2009c; Figdor, 2010; Haug, 2009). Shoemaker's account of realization could be of use to arbitrate between the claims that cases of multiple realization are rare and the view that multiple realization is common.

Second, there is the question of how an account of realization can fit with new

mechanistic accounts of explanation in neuroscience. Pursuing this line of enquiry with a worked out account of realization has obvious benefits. Clarity regarding the metaphysics of realization could clarify what it means for mechanisms to explain mental properties.[49] Shoemaker's account of microrealization would also benefit from being shown to be compatible with the epistemic goals of new mechanism because new mechanistic explanations provide a way of explaining how the constituent states of affairs of a mechanism realize a property.

Finally, the arguments I raised regarding the manner by which realization is distinct from identity open up further questions regarding the precise logical nature of the realization relation. For example, besides not being one-to-one or symmetric, is realization transitive? There has been renewed interest in identity theory[50], and applying a detailed account of realization will help to make it clear what is at stake in contemporary debates between modern versions of identity theory and functionalism. Comparing realization to identity as competing relations reestablishes the contrast between functionalism and identity theory. A carefully worked out defence of multiple realization remains the strongest argument by functionalists against identity theories. In the next chapter I address arguments against the possibility of multiply realization. I argue that these arguments can be re-interpreted as defeaters for alleged cases of multiple realization, rather than as general refutations of the possibility that mental kinds are multiply realizable. In the fourth chapter I present cases of multiple realization drawn from the neuro- and cognitive science of language that are not explained away by defeaters of cases of multiple realization.

[49] Craver's (2007) influential view that the search for mechanistic explanation acts as a regulative ideal and unifies research goals in neuroscience has been recently criticized (e.g., Barrett 2014; Chirimuuta 2013; Sullivan 2009).

[50] Polger and Shapiro (2016) mount a defence of a modest identity theory against multiple realization.

Chapter Three: Empirically motivated arguments against multiple realization

3. 1. Introduction

In this chapter I review a series of arguments developed to deny that mental kinds are multiply realized and highlight key details of those arguments. The arguments against instances of multiple realization advance constraints or requirements on what counts as a genuine example of multiple realization. I summarize those requirements. In the next chapter I present examples from the cognitive neuroscience of language that meet those requirements. The examples I discuss are language lateralization, models of reading, and bi- or multi- lingualism.

In this chapter I focus on strategies used to deny that mental kinds are multiply realized based on empirical evidence. Thomas W. Polger and Lawrence A. Shapiro challenge defenders of multiple realization to provide concrete examples of multiple realization, presumably drawn from cognitive or brain sciences (Polger and Shapiro 2016). They argue that there are, in fact, relatively few (or no) clear cases of multiple realization of mental kinds. They advance several strategies that can be used to defeat or explain away apparent examples of multiple realization. The challenge to instances of multiple realization does not directly refute the metaphysical or conceptual possibility of multiple realization. However, a complete absence of discovered cases of multiple realization can be interpreted as indirect evidence against the view that mental kinds are multiply realizable.

There is another strategy that challenges the possibility of multiple realization more generally. There are two arguments in this vein that I take up in this chapter as a lead in to the empirically motivated arguments against instances of multiple realization, the Grain Argument and Shapiro's Dilemma. I present these arguments as conceptual challenges to the possibility of multiple realization and respond to them. I argue that neither the Grain Argument nor Shapiro's Dilemma succeed in undermining the conceptual or metaphysical possibility that mental kinds are multiply realizable. However, both arguments can be modified so that their scope presents a more limited challenge to

multiple realization. Both arguments can be used for guidance in constructing defeaters for instances of multiple realization. I describe how these direct arguments against multiple realization are modified to produce indirect challenges to multiple realization. I take the arguments against multiple realization in the order they appeared historically: I begin with William Bechtel and Jennifer Mundale's Grain Explanation (1999), next I present Shapiro's Dilemma, (Shapiro 2000), and I conclude with summaries of several of the strategies Tomas Polger and Lawrence Shapiro use to argue against cases of multiple realization (Polger and Shapiro 2016).

The starting point for the development of arguments against multiple realization that I present in this paper is an influential criticism of multiple realization raised by William Bechtel and Jennifer Mundale (1999). However, they do not advance the Grain Argument themselves. Instead, Bechtel and Mundale advance the Grain Explanation to show why many philosophers have the persistent, but mistaken, intuition that mental states are multiply realized. They use the Grain Explanation to reveal the source of this mistaken intuitive belief in the plausibility of multiple realization. Broadly speaking their diagnosis is that we do not describe mental kinds and physical kinds with the same degree of accuracy, precision, or detail. Physical kinds are described in more detail than the mental kinds they supposedly realize. For example, philosophers talk about general mental states or properties, such as “being in pain” or “feeling hunger” (e.g., Putnam 1975), whereas descriptions of brain states may involve multiple brain regions and changes in the amount of activation in those areas over short periods of time. The mismatch between the descriptions of these different kinds goes unnoticed, and this gives philosophers the impression of greater variability in one domain (neural kinds) than in the other (mental kinds). This explanation for the mistaken credence in multiple realization can be turned into an argument against multiple realization. Their observation about grains of description is adapted into an argument against multiple realization by claiming that the appeal of multiple realization is the result of a mistaken intuition. Apparent multiple realization is not the same as evidence that mental kinds are in fact multiply realizable.

The second direct argument against multiple realization I take on in this chapter is

Shapiro's Dilemma, which argues that all potential cases of multiple realization fail by falling to one of the two horns of the dilemma Lawrence Shapiro proposes (Shapiro 2000). The dilemma proposes two outcomes for alleged cases of multiple realization. The first horn of the dilemma addresses cases where the two (or more) physical kinds that realize a mental kind fail to differ in relevant ways, and should thus be counted as a single kind (so no multiplicity); second horn deals with cases where the physical kinds that realize the mental kind differ in relevant ways, so there is not a single mental kind that is realized.

Both the Grain Argument and Shapiro's Dilemma can be re-framed to present more limited challenges, not to the possibility of multiple realization, but instead to particular cases of alleged multiple realization. John Bickle, Thomas Polger, and Lawrence Shapiro have each advanced re-interpretations of the grain argument that appeal to empirical evidence to challenge purported cases of multiple realization in this way (Bickle 2003; Polger 2004; Shapiro 2008). When the arguments are re-framed in this manner authors describe empirical investigations into cases where we expect to find multiple realization and argue that we do not, in fact, find that correctly individuated mental kinds have multiple realizers. Rather, researchers discover one of two alternative interpretations: either, the mental kind is realized in the same way by the same neural kind found in different individuals (or species), or it is uncovered that differences in neural kinds track differences in mental kinds, once those mental kinds are described with sufficient detail. Understood in this manner, the Grain Argument challenges defenders of multiple realization to present genuine cases of multiple realization found by empirical studies. Failing to discover any actual cases of multiply realized mental kinds should decrease our relative confidence in the possibility that mental kinds are multiply realizable. If there are no cases of multiple realization to be found, then that counts as inductive evidence against mental kinds being multiply realized.

To that end Polger and Shapiro (2016) develop a series of strategies to show that mental kinds and brain kinds align.[51] The commonality between the empirical

[51] Polger and Shapiro advance a version of identity theory they refer to as 'modest identity theory' as a competitor to functionalism (Polger and Shapiro 2016, 144-5, 152, 162, 219). To highlight the contrast between identity theory and functionalism Polger and Shapiro sometimes refer to functionalism as

reinterpretations of the Grain Argument and Shapiro's Dilemma is that both arguments explain away purported cases of multiple realization[52] via two types of strategies: either one can argue that when there are two brain kinds that appear to realize the same mental kind there are actually two different mental kinds that differ to the extent that the brain kinds differ, or it can be argued that there is a single mental kind and there is only a single brain kind as well. Polger and Shapiro call arguments of the latter kind *unification* strategies and arguments of the former type are *kind splitting* strategies.

Arguments to show that there are no empirically discovered cases of multiple realization are developed by looking carefully at research and practices in the mind and brain sciences. Attention to the details from specific cases from neuro- and cognitive science are used to illustrate why presumed cases of multiple realization fail to count as genuine. To respond to arguments claiming that there are no cases of multiple realization, it suffices to show that there have in fact been legitimate cases of multiple realization discovered in the mind and brain sciences. This kind of reply has been advanced by several authors (e.g. Figdor 2010; Aizawa and Gillett 2009a, 2009b, 2009c; Aizawa 2009). In the next chapter I add to these replies by contributing new examples of multiple realization drawn from research in the cognitive neuroscience of language. I discuss three different areas of research in language: language lateralization, models of reading, and second- or multi- language learning. In each of these areas I present case studies that should correctly be counted as evidence for multiple realization. I contrast these with other cases where apparent examples of multiple realization are correctly explained away through the application of one or more of the empirical defeaters Polger and Shapiro propose.

3. 2. Arguments against multiple realization

In this section, I present the arguments against the possibility of multiple realization in

'realization theory' (*Ibid*, 11).

[52] As Polger and Shapiro do in their book, I will, from now on, simply refer to alleged cases of multiple realization as cases of multiple realization, with the understanding that claims of multiple realization are empirical and subject to revision, such that some cases merely may have the appearance of multiple realization, but upon close inspection fail to count as examples of multiple realization for one reason or another.

general. I begin with the Grain Argument, and its inspiration from Bechtel and Mundale's (1999) Grain Explanation, and second I present Shapiro's Dilemma (2000). I describe the challenges that each argument raises against the possibility of multiple realization. In the case of the Grain Argument, I describe how multiple realization is explained away as a mistaken intuition. I argue that understood as a general argument against the possibility of multiple realization, this strategy fails. However, a weaker interpretation of the argument that challenges alleged cases of multiple realization can still succeed at decreasing our confidence that any mental kinds are in fact multiply realized. I treat Shapiro's Dilemma in a similar manner. I present the dilemma as a challenge to the possibility of multiple realization, and in reply argue that the dilemma rests on a misrepresentation of the original argument from multiple realization. The dilemma only succeeds if one assumes the kinds described by the dilemma are functionally individuated kinds. But again, a weakened version of Shapiro's Dilemma can be raised to challenge alleged cases of multiple realization. I conclude this section by describing how the Grain Argument and Shapiro's Dilemma inspire strategies used by Polger and Shapiro to explain away cases of multiple realization.

3. 2. 1. The Grain Argument

The Grain Explanation, when it was first presented by Bechtel and Mundale (1999), was not offered as an argument against multiple realization. Bechtel and Mundale presented two other arguments to make their case against multiple realization, both of which appeal to the success of certain empirical methods. Both arguments attempt a *reductio* of multiple realization based on supposed consequences of accepting multiple realization. The first argument is based on the view that researchers in neuro- and cognitive science implicitly assume the falsity of multiple realization, based on the manner in which they decompose and analyze cognitive systems. Bechtel and Mundale claim that assuming mental kinds are not multiply realizable enables researchers to enjoy greater success in understanding cognition. If mental kinds were multiply realized, this assumption would not lead to fruitful or successful research in the relevant fields, so mental kinds must not be multiply realized. The second argument proceeds in a similar fashion. In this case

Bechtel and Mundale point out that if mental kinds are multiply realized, then information about neuroanatomy would not be helpful in understanding cognition. But, they argue, neuroscientific discoveries have been useful to our understanding of cognition, so mental kinds are not multiply realized.[53] Both of the arguments against multiple realization that Bechtel and Mundale advance appeal to empirical evidence for support.[54]

On the assumption that their arguments against multiple realization are successful Bechtel and Mundale wonder why nevertheless so many philosophers have the persistent intuition that mental kinds are multiply realized. To explain why the belief in multiple realization is so widespread despite the apparent incompatibility of multiple realization with current scientific practices, Bechtel and Mundale seek to explain what the source of the impression that there are cases of multiple realization is. The cause, they claim, is that descriptions of psychological kinds are often less precise than the descriptions of physical, biological, or neurological correlates. The broad descriptions of psychological kinds allow for the possibility that activity in different physical systems is correlated with the presence of a single psychological kind. However, descriptions of neurological kinds can be more or less specific as well. Bechtel and Mundale contend that when psychological kinds are given coarse descriptions, the corresponding physical system should be described in equally coarse terms (1999, 202). Or alternatively, if one were to adopt the fine-grained description given to physical kinds, then the correlated mental kinds should be described in equally fine-grained detail. By matching the grains of descriptions of psychological and neurological kinds apparent cases of multiple

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[53] Both of these arguments are related to Jerry Fodor's (1974) argument for the autonomy of the special sciences based on multiple realization. Fodor deploys the possibility of multiple realization to defend the independence of psychology and other special sciences from the physical sciences. Bechtel and Mundale turn Fodor's argument on its head. This illustrates that one philosopher's *modus ponens* is frequently another's *modus tollens*. Fodor, and Bechtel and Mundale agree on the conditional statement, 'if multiple realization is true, then the special sciences are autonomous'. Fodor then affirms the antecedent 'Multiple realization is true', leading to the conclusion that the special sciences are autonomous, whereas Bechtel and Mundale deny the consequent and accept that 'The special sciences are not autonomous', and therefore conclude ' Multiple realization is false'.

[54] Carrie Figdor (2010) presents a detailed analysis of the arguments in Bechtel and Mundale (1999). She summarizes both arguments and describes the context for the use of empirical evidence by biologists and neuroscientists that is relevant in assessing the possibility of multiple realization. She also helpfully labels the two arguments against multiple realization that Bechtel and Mundale advance as 'the Argument from Empirical Fruitfulness' and 'the Argument from Non-Autonomy', or 'AEF' and 'ANA' for short.

realization can be explained away.

Doing away with mismatches between grains of descriptions of mental and physical kinds provides a way of explaining away the appearance that there are cases of multiple realization. It is a short step from explaining away the appearance of multiple realization to mounting an argument against multiple realization. Dividing up the conceptual language used to describe mental kinds and physical kinds so that those kinds are described with equally precise or general terms leads to the position that piecemeal identities between physical and mental kinds hold. Fine grained mental kinds are supposedly identical with fine grained physical kinds, and coarse grained mental kinds are identical with coarse grained physical kinds. When the Grain Argument is read in this manner it can be seen as an attempt to rehabilitate local reductionist views, such as the one defended by John Bickle.[55] (1998; 2003) Insofar as the Grain Argument is used to advance a type of local reductionist view it does not add any novel support to those accounts, and it is open to the same criticisms raised against such views. Interpreting the Grain Argument as simply lending support to the possibility of local reductionist views doesn't reflect the kind of evidence its advocates use to defend it. Local reductions of mental kinds might be a consequence of the Grain Argument, but are not themselves evidence in favour of the Grain Argument.

Support for the Grain Argument comes from appeals to case studies drawn from neuroscience. Changing the focus from discussing the conceptual possibility of whether mental kinds and physical kinds align to looking at how mental and physical kinds are described in particular cases drawn from neuro- or cognitive science, and whether those descriptions involve identities that hold between the mental and physical kinds, provides inductive evidence for or against a more general form of the Grain Argument. The innovation of the Grain Argument lies in the notion that there are mismatches between the descriptions of mental kinds and physical kinds, and that when those mismatches are controlled for, apparent cases of multiple realization are explained away. If there are no examples of multiply realized mental kinds after the granularity of descriptions of mental

[55] Earlier proponents of local reductions include Patricia Churchland (1986), Berent Enç (1983), and Jaewong Kim (1972).

and physical kinds are matched, this counts as evidence to decrease our relative confidence that mental kinds can be multiple realized. There is something suspicious about insisting that something exists or occurs, but never being able to provide an example of its existence or occurrence.

The empirical interpretation of the Grain Argument delivers a general challenge to defenders of multiple realization: present genuine cases of multiple realization where the grain of description of the physical kind(s) that realize the psychological kind matches the grain of description of that psychological kind. To see how the Grain Argument deals with a purported case of multiple realization, I present a simplified case. Suppose that the psychological kind 'memory' is offered as an example of a multiply realized mental kind. This claim is supported by the observation that among humans there are many different kinds of memory, including declarative memory, procedural memory, spatial memory, and semantic memory, and each of these kinds of memory in humans can be localized to different areas of the brain (Thomson and Kim 1996; Squire 2004; Patterson, Nestor, and Rogers 2007). The evidence for the localization of each kind of memory to a different brain area is based on lesions to different areas of the brain that disrupt different aspects of memory and using brain imaging techniques to discover which areas (or networks of areas) of the brain are more active while performing relevant kinds of memory tasks.

Each of these different aspects of memory can be given a finer grained description and treated as a kind on its own, and each of these finer grained psychological kinds can then be associated with a single physical kind, described at the same level of detail. For example, McDermott et al. (1999) studied the differences in memory for faces compared to words. They compared participants' ability to recognize whether an unfamiliar face was presented to them earlier in the study, with the ability to recognize whether a word (all words were concrete nouns) had been presented to them earlier in the experiment. They found that for both the encoding phase, when the novel faces or words were presented, and the recall phase of the experiment, there were distinct areas of the brain that showed greater activity, activation for faces showed right hemisphere lateralization whereas words showed strong left hemisphere activation (McDermott et al. 1999, 634). This experiment further divides declarative memory into sub-categories based on the content of the

memory (faces vs. words). Given the prominent difference in the localization of the different kinds of declarative memory, this further division of declarative memory is supported by anatomical differences for the brain regions that are most active for the relevant kind of memory task. In light of this type of result, memory is no longer treated as a single kind that is realized in multiple ways. The original supposition, that memory is multiply realized, given the wide variety of apparent physical realizers of memory, is unsupported because the grains of descriptions of both the physical realizers and mental kinds (kinds of memory) are stated in more precise terms than simply 'memory'. The specified kinds of memory do not have multiple realizers once the grains of description of the kinds of memory are matched to the grains of description of their realizers.

The details of how memory is decomposed and how the different aspects identified by the decomposition are studied lend credibility to the notion that multiple realization is a product of mismatched descriptions. It is not clear how systematic one can be in matching the granularity of one's descriptions of mental and physical kinds. There is an intuitive sense that in some cases there are mismatches, but it would be going too far to suggest that there is a way of assessing when exactly the grains of descriptions of mental and physical kinds are properly matched.[56] This problem bears some resemblance to the challenges faced when trying to advance a systematic way of classifying entities into levels. I am here talking about the kind of classification of entities to levels that plays a role in accounts of reduction where entities at a lower level compose entities at a higher level, for example, molecules are at a lower level than animals' bodies, but at a higher level than protons and electrons.[57] The Grain Argument's appeal to 'grains of description' is similar to the idea that the absolute size of an entity serves as guide to classifying

[56] The challenge of advancing a systemic taxonomy of cognitive kinds becomes even more complex if one attends to the experimental practices in laboratories that are used to operationalize those kinds. As Jacqueline Sullivan points out, variability among the experimental practices used to investigate psychological and cognitive kinds introduces complications to providing stable descriptions of those kinds (Sullivan 2016). The importance of experimental practices, and the challenges that variation among those practices introduces, to identifying and comparing cognitive and psychological kinds is frequently overlooked by philosophers (Sullivan 2009).

[57] Levels of explanations also play a role in certain reductionist views. I will not enter into a discussion of this sense of levels, though I suspect that levels of explanation and the grains of description given for various mental and physical kinds are connected in some way to levels of entities. I will not speculate on the exact nature of the connection here.

entities together (e.g., everything smaller than $1x10^{-10}$m, but larger than $1x10^{-14}$m belong to the same level). This rough definition of levels doesn't work for a variety of reasons (for a discussion of different ways of dividing entities into levels see Wimsatt 2006; 2000). For example, we know that a single snake can cause an entire herd of buffaloes to stampede, or that splitting a single atom can have an impact on entities many times the size of the atom. Determining whether a mental kind (or kinds) is a match for a physical kind (or kinds) based on the degree of detail in the descriptions of those kinds will be unreliable.

A solution that has been adopted to delineate different levels within a mechanism could be adapted to aid in assessing whether descriptions of mental and physical kinds are mismatched or not. Carl Craver argues that levels within a mechanism are determined in a manner that is relative to the operation of that mechanism (Craver 2007). Talk of particular levels cannot be applied outside the context of analyzing a particular mechanism. Chambers of the heart are at a lower mechanistic level than the heart itself in a mechanistic explanation of how blood circulates in the body, and alveoli are at a lower mechanistic level than lungs in a mechanistic explanation of human respiration, but a comparison of the levels at which alveoli and heart chambers can be located is a non-starter unless one is discussing a mechanism that involves both entities. In a similar fashion, whether a particular physical kind is a good candidate for counting as a realizer of a particular mental kind should be decided on a case by case basis. But, this limitation blunts the force of the Grain Argument against the view that it is possible for mental kinds to have multiple realizers. Nevertheless, this is the direction in which the objections to cases of multiple realization I discuss in this chapter go. Polger and Shapiro argue that assessments of instances of multiple realization are 'specific and contrastive' (Polger and Shapiro 2016, 26). They object to questions with the general form, 'Is mental kind M multiply realized?', and insist that instead one must ask, 'Are physical kinds P1 and P2 realizers of mental kind M?' *(Ibid*, 67).

Polger and Shapiro (2016) use the example of memory to illustrate the strategy they call 'kind splitting'. Kind splitting undermines the possibility of multiple realization in cases where the realized kind is divided into multiple kinds that track the variation

among the realizing kinds. Polger and Shapiro acknowledge that if there are differences only at the level of the realizer, then it is not mandatory to split the realized kind. They point out that whether a psychological or cognitive kind should be split into multiple kinds is not something that can be decided in advance or in principle. The degree to which causal powers ascribed to a kind are unified or disunified is discovered empirically. To discover whether a kind should be split, Polger and Shapiro defer to the choices regarding that kind made by the scientists who use or study the kind (or kinds).[58]

The objections that can be raised at this point apply to particular instances or cases of multiple realization. The changes to the Grain Argument mean that it no longer presents a general objection to the possibility of multiple realization. This illustrates the way that the scope of an argument against the possibility of multiple realization can be narrowed to apply to specific cases. In the next section I discuss an argument by Shapiro (2000) that defends a principled reason for either grouping or splitting kinds to exclude the possibility of multiple realization. The discussion of Shapiro's Dilemma follows the same pattern. I present the general objection to the possibility of multiple realization that the argument presents, respond to that argument, and show how a weaker version of the argument that can be applied to particular cases can be salvaged from the original argument.

3. 2. 2. Shapiro's Dilemma

In this section I outline an argument Lawrence Shapiro (2000) raises against the possibility of multiple realization. The argument aims to force defenders of multiple realization into a position where they must accept that when a kind is apparently multiply realized it is either because there are relevant differences between the realizers, and so the

[58] Polger and Shapiro's decision to defer to scientists for the individuation of kinds is not something that I take issue with here. I will, however, flag this move as being potentially worrisome. It seems equally likely that scientists studying various phenomena might refrain from deciding whether a particular operationalization in one case is of the same kind as a kind studied using a different operationalization in a different setting, preferring instead to point out that such a concern is a 'philosophical question'. Russell Poldrack raises this concern in his critique of some trends in neuroimaging studies, " Unfortunately, such task analyses are very rarely presented in neuroimaging papers. Whereas formal theories from cognitive psychology could often provide substantial guidance as to the design of such tasks, it is uncommon for neuroimaging studies to take meaningful guidance from such theories. Rather the task comparisons in many studies are based on intuitive judgements regarding the cognitive processes engaged by a particular task." (Poldrack 2010, 149)

realized kind should be split, or there are no relevant differences between realizers, in which case there is really only one kind that does the realizing, so there are not multiple kinds of realizers, and therefore no multiple realization. The argument seeks to show that either there is an in principle reason to split a kind, or there is an in principle reason to group realizers together as a single kind. Shapiro's argument comes in the form of a dilemma for defenders of multiple realization. He summarizes the dilemma as follows,

> Either the realizing kinds truly differ in their causally relevant properties, or they do not. If they do not, then we do not have a legitimate case of multiple realizability and MRT [multiple realizability thesis][59], in this given instance, is false. If the realizing kinds do genuinely differ in their causally relevant properties, then, it seems, they are different kinds. But if they are different kinds, then they are not the same kind, and so we do not have a case in which a single kind has multiple realizations. (Shapiro 2000, 647.)

This dilemma aims to show that there are no multiply realized kinds, because the individuation of kinds based on their causally relevant properties precludes that result. Presented in this form, the dilemma appears to be an *a priori* challenge to multiple realization.

Polger and Shapiro repeat the mantra that a case of multiple realization requires that the various realizers be *differently the same* (Polger and Shapiro 2016, 67-73, 89-90, 98, 110, 130, 166). The slogan 'differently the same' is meant to emphasize the idea that a mental kind (or any realized kind) has multiple realizers only if the realizing kinds realize the same kind in different ways. Multiple distinct instances of the same kind realizing the same property is not multiple realization. Realizers are multiple realizers of a kind if they are different in kind, the 'differently' of 'differently the same', and at the same time when instances of the realized kind are realized by those different kinds there cannot be differences in the realized kind, the 'same' in 'differently the same'. What they are emphasizing is their view that the differences among realizers in potential cases of multiple realization must be differences that are *relevant* to way that a kind is realized. Differences among realizers must be causally relevant to the way that various realizers realize a kind in question. The worry Shapiro's Dilemma brings to the fore is that if there

[59] MRT is the name Shapiro gives to Fodor's argument against reductionism based on multiple realization.

are relevant differences in the causal properties of the realizers of a kind, then there is a reason to split the realized kind into two distinct kinds, on the basis of those different causal properties. The dilemma challenges the defender of multiple realization to justify why, despite those differences, the realizers should still be thought of as realizing the same kind. Shapiro's Dilemma is supposed to rule out cases where realizers are samely the same, or differently different.

An example of realizers that are 'samely the same' is two corkscrews with differently coloured handles. To argue that not all differences among realizers amount to evidence for multiple realization Shapiro considers the example of the kind 'corkscrew'. To show that some differences are irrelevant with respect to multiple realization Shapiro points out that the colour of a corkscrew makes no difference with respect to the cork-removing properties of a corkscrew. So a yellow waiter's corkscrew and an orange waiter's corkscrew do not count as different realizers of the property 'cork-removing'. In contrast, a waiter's corkscrew and a winged corkscrew differ with respect to some of their cork-removing properties, and could be viewed as multiple realizers for the property 'cork-removing', though there may be other reasons to deny that they are multiple realizers of the same property. An example of realizers that are differently different is the case of the different neural correlates of memory that were discussed in the previous section. The differences among kinds of neural correlates track the differences among the kinds of memory that they each realize.

Shapiro's Dilemma presents a general problem for the possibility of multiple realization. The dilemma divides realizations into two kinds of cases; there are those cases where there is no causal difference among the realizers and there are those cases where there is a causal difference. Looking at the first horn of the dilemma, there is a difference in Shapiro's interpretation of how physical kinds are to be grouped together from the way that functionalists and defenders of the multiple realizability group mental kinds. Contrast Shapiro's view that realizers are grouped into kinds based on their causal profiles with the idea that realizers should be grouped into kinds based on their material composition. If physical kinds are individuated based on their constitution, then two physical kinds with different constitutions could both realize the same mental kind in the

same way, yet it would be true that there were two separate kinds that realize a mental kind, which should qualify as an example of multiple realization of a mental kind. Shapiro argues that the characterization of systems in terms of their functionality rather than their physical constitution is necessary to present genuine cases of multiple realization. He argues that differences in the way that something is realized cannot merely be differences between what something is made out of. To illustrate he presents another example of two kinds of corkscrews.[60] (Shapiro 2004, 56-57)

This case contrasts two waiter's corkscrews, one made of steel, the other aluminium. Again in this case he denies that the corkscrews made from different metals are different realizers of the same kind. To explain why, Shapiro points out that the cork-removing property of both corkscrews is the same. There are no differences in the way a cork is removed that depend on the material the corkscrews are made from. Shapiro acknowledges that a corkscrew cannot be made from just anything, but so long as the substance used to make the corkscrew is sufficiently rigid, durable, and hard, then it doesn't make a difference to the way the cork is removed, and so doesn't count as a relevant difference. It might be the case that durability, hardness, or rigidity are realized differently by different substances, but this asks a different contrastive question than the one regarding the multiple realizability of cork-removing.[61] In discussing his example of differently coloured corkscrews, Shapiro concludes,

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[60] This argument is repeated by Polger and Shapiro (Polger and Shapiro 2016, 65). In discussing the manner by which relevant causal powers are identified, Shapiro invokes Bechtel and Mundale's discussion of grains of description (Shapiro 2004, 48).

[61] Polger and Shapiro draw attention to one of the consequences of assessing multiple realization based on these specific contrastive questions. The principle, as they state it, is, “Multiple realization doesn't percolate up in this way.” (2016, 61) So, parts or properties that are components of a kind may be multiply realized, but this does not entail that the kind itself is multiply realized. This principle seems to me to be more contentious than Polger and Shapiro make it out to be, but the examples I present in defence of multiple realization do not rely on multiple realization percolating up from one level to another, so I will not challenge the principle here. It is, however, curious to note that their argument against multiple realization at one level invokes multiple realization at another level. To deny that variation in the composition (aluminium or steel) of a waiter's corkscrew is evidence that waiter's corkscrews are multiply realizable, Polger and Shapiro argue that the causally relevant property a corkscrew requires is rigidity. As long as the corkscrew is rigid, the differences in composition are not relevant differences. But, to make this argument, Polger and Shapiro endorse the idea that rigidity is multiply realized. Since the multiple realization of a particular kind is an empirical question, there is no reason to deny that in principle most psychological or cognitive kinds are not multiply realized, but one should ask themselves why we should expect to find fewer cases of multiple realization of psychological or cognitive kinds than multiple realization in other areas of scientific inquiry.

> The moral of this example is that multiple realizations count truly as *multiple* realizations when they differ in causally relevant properties – in properties that make a difference to how they contribute to the capacity under investigation. (Shapiro 2000, 644)

This reiterates one of the principles upon which Shapiro's Dilemma rests: by differing in their causally relevant properties, many different kinds can be individuated, but each is a realization of only one kind, the kind as it is individuated on the basis of its causal properties. Where there are no causally relevant differences there are realizations of only one kind, not one kind that is multiply realized.

This argument against multiple realization is somewhat peculiar. By accepting that mental kinds are individuated on the basis of their causal profiles, rather than by other physical facts individuative of the physical kinds that realize those mental kinds, the argument seems to turn on accepting a functionalist account of mental kinds. On the supposition that mental kinds are individuated based on their causal powers, each mental kind cannot but have a realizer that possesses those causal powers. But the physical kinds that act as realizers are not individuated only on the basis of the same causal or functional properties that are used to individuate mental kinds. This interpretation of what would, or would not, constitute a case of multiple realization seems to misinterpret what type of variability among realizers defenders of multiple realization have in mind. What Shapiro's Dilemma really shows is that functionally individuated kinds cannot be multiply realized by other kinds that are individuated on the basis of those *same functional properties*. And this is true only if we accept that additional functional properties found in one kind, and not in another, which are not relevant to the way that kind is realized, cannot play a role in individuating one kind from another. The importance of causally relevant differences, rather than *any* differences among realizers, as a condition on multiple realization is an issue I address in the next section.

Moreover, Shapiro accepts that there are genuine instances of multiple realization. He provides several examples of ways that the property 'cork-removing' is multiply realized. 'Cork-removing' is multiply realized because a cork can be removed by a corkscrew, a cork puller or by an air pressure cork pump. A corkscrew works by piercing a cork and then, by the use of some leverage (the type of leverage will differ depending

on whether a waiter's corkscrew or a winged corkscrew is used), pulling the cork out of the bottle. A cork puller does not pierce the cork, but rather slides two prongs along the sides of the cork. The prongs squeeze the cork so that it can be pulled out (using a twisting motion), but typically no lever is involved. A third method of removing a cork involves piercing the cork all the way through with a needle. Using a pump air pressure in the bottle is increased until the cork is forced out. The differences in the ways that corks can be removed evokes the kinds of differences that are relevant in developing patents. Michael Dawson (1998) provides another illustrative example of how different devices can perform the same function, using the example of different patents for the amplification of telegraph signals (Dawson 1998, 105-106). Dawson relates the story of how Thomas Edison developed a signal amplifier for signals sent along telegraph wires that did not use an electromagnet. Edison was able to replace the amplifier that used an electromagnet with one the employed a piece of chalk that was rotated by an electric motor. Dawson points out the moral of this example,

> The main point of this example is simply this: things that are extremely different physically (in particular, things recognized as being so different that they do not fall under some other inventor's patent!) can have exactly the same function. Thus one approach to describing and explaining a complicated system would be to describe its components in terms of the functions that they perform, and in terms of their physical nature. (Dawson 1998, 106)

Dawson points out that there are two different ways of describing objects, one is in terms of their function, another is in terms of their composition. Two signal amplifiers that used electromagnets made from different metals would not have sufficed to avoid the patent claim in the manner that Edison's invention did.

An important aspect of assessing potential cases of multiple realization lies in identifying which properties are causally relevant for the realization of a particular kind. As was the case with the Grain Argument, there is not a clear cut or systematic way to do so for different mental kinds. The manner in which realizers are judged to be the same or different is not something that can be determined *a priori*. It is a matter of empirical investigation to find out which realizers possess the relevant causal properties. So, again this argument against the possibility of multiple realization ends up providing guidance

for arguments that explain away instances of multiple realization, rather than as an argument against the possibility of multiple realization. Shapiro's Dilemma acts as a heuristic for assessing potential cases of multiple realization tout court. The first horn of the dilemma calls attention to cases where our intuition is that there should be differences among realizers, given the differences between entities in which instances of the realized property occur, but that intuition is not born out. The second horn of the dilemma draws attention to the way that realized kinds are grouped together. This horn of the dilemma draws critical attention to cases where differences among realized kinds are dismissed, but those differences are the same differences that are due to differences among the realizers.

Both the Grain Argument and Shapiro's Dilemma ask that we pay closer attention to the details of how realizers are matched to the properties that they realize. And in both cases determining which details are important or which causal powers are relevant requires us to look at specifics relative to particular potential cases of multiple realization. In the next section I present some general principles Polger and Shapiro (2016) advance as defeaters of instances of multiple realization.

3. 3. Indirect arguments against multiple realization

In this section I present four strategies Polger and Shapiro use to explain away apparent cases of multiple realization: Unification, Individual Differences, Kind Splitting, and Abstraction and Idealization.[62] (Polger and Shapiro 2016) One way of approaching the first three strategies is to treat them as ways to argue that particular cases fall to one of the two horns of the limited version of Shapiro's Dilemma I presented in the previous section. Unification and Individual Differences are both used to argue that alleged cases of multiple realization fall to the first horn of Shapiro's Dilemma. Kind Splitting is used to

[62] Polger and Shapiro advance two additional strategies, Convergence and Homology, and Heuristics, which I do not discuss. I do not take up Convergence and Homology because the examples I discus in the next chapter apply only to humans. I do not speculate on the evolutionary history of language abilities, so neither the evolutionary history of those abilities, nor cross species comparisons are relevant to my discussion. In the case of Heuristics, Polger and Shapiro do not mean to invoke a general account of heuristics, but limit their discussion to the way that mind-brain identities are posited as a heuristic in the mind-brain sciences. As such it acts mainly as evidence for the view they advance in place of realization theory, modest identity theory. A discussion of their positive view is beyond the scope of this paper.

argue that the second horn explains away instances of multiple realization. Abstraction and Idealization, the final strategy I address, plays a different role. Polger and Shapiro appeal to the practices of abstraction and idealization in the mind and brain sciences to explain why some instances are mistakenly thought to be cases of multiple realization. Before I outline the particulars of each strategy, I lay out Polger and Shapiro's general account of multiple realization.

To make it clear what their target is, Polger and Shapiro present four conditions that must be met for a case to count as an example of multiple realization. Their account applies to instances, labelled 'As' and 'Bs', that belong to the same kind under one classification system (the realized kind), but are distinguished under another classification system (the realizers).[63] This fits the general structure for cases of multiple realization; a single kind in one classificatory system has more than one kind of realizer when those realizers are classified in another way. They call this their recipe for multiple realization,

> Official Recipe:
> i. As and Bs are of the same kind in model or taxonomic system S1.
> ii. As and Bs are of different kinds in model or taxonomic system S2.
> iii. The factors that lead the As and Bs to be differently classified by S2 must be among those that lead them to be commonly classified by S1.
> iv. The relevant S2-variations between As and Bs must be distinct from the S1 intra-kind variation between As and Bs. (Polger and Shapiro 2016, 67)

The first two conditions are formalizations of the intuitive requirements that for a kind to be multiply realized there must be something the kind has in common (i), and that there are differences between realizers of that kind (ii). The first two conditions also point toward Polger and Shapiro's view that determining whether an example counts as a case of multiple realization must be done in a specified context. The taxonomic systems in which the relevant kinds appear at minimum indicate a starting point for describing the contextual question that contrasts whether a kind is multiply realized, relative to the potential realizers under consideration. The third condition (iii) makes explicit what is required for the differences and similarities to be relevant. Finally, the forth condition (iv)

[63] Polger and Shapiro describe what they mean by 'taxonomic systems' primarily via ostention. They talk about a 'science of eyes', that classifies kinds of eyes, or a 'science of corkscrews' that classifies corkscrews. Generally, the taxonomic systems in which the kinds appear are informed by scientific investigations that aim to decompose and describe the functioning of the kinds in question.

places a limit on the kind of relevant differences (ii) requires by stipulating that there must be tolerance for variation within a kind.

Polger and Shapiro argue that asking whether a particular kind is multiple realized requires putting the question into a specific context, "We think that questions about realization and multiple realization are always *specific* and *contrastive*." (2016, 26) The first two parts of their recipe, (i) and (ii), point to how that context can be fixed. The context Polger and Shapiro require involves contrasting two particular kinds, as they are individuated in one classification system, and asking whether those two kinds are relevantly different realizers of a kind from another system. The third condition gives the conditions for determining which factors are candidates for relevant differences. The role of relevant differences has already been raised by Shapiro's Dilemma. Polger and Shapiro are invested in denying that multiple realizing is ubiquitous; the relevant differences should be relevant in a way that generates interesting cases of multiple realization. The analogy with patent judgements that Dawson raises illustrates the kind of differences necessary for multiple realization (or at least interesting multiple realization) that Polger and Shapiro have in mind.

The strategies I discuss next seek to show that *prima facie* cases of multiple realization lack one of the ingredients in the recipe Polger and Shapiro defend. In some cases they fail to count as genuine multiple realization because the differences between realizers are not relevant differences. In other cases they fail because the two (or more) realizers are too diverse to be properly unified as a single kind. Unification, Individual Differences, Kind Splitting and Abstraction and Idealization are used to highlight the ways that realizers are "*samely* the same, [or] differently different." (Polger and Shapiro 2016, 89)

3. 3. 1. Unification

The *unification* strategy is used to argue that some cases should fall to the second horn of Shapiro's dilemma. To use unification to explain away an apparent case of multiple realization, what must be demonstrated is that the reason two different physical kinds realize the same psychological process is the two physical kinds share a common feature

that enables them to both act as realizers for the psychological process. The realizers are samely the same (relevantly causally the same).

Polger and Shapiro illustrate this strategy by using it to explain away the presumption of multiple realization in the famous example of the rewired ferrets. Mirganka Sur and his colleagues altered the neural connections in ferrets so that connections from the ferrets' eyes were disconnected from the visual cortex and reconnected to their auditory cortex (Sharma et al. 2000; Roe et al. 1992). After a period of time the rewired ferrets were capable of performing behavioural tasks that relied on visual capacities, though not as well as normal ferrets (Von Melchner et al. 2000). The importance of activity in the auditory cortex is supported by single cell recordings from the rewired ferrets' auditory cortices (Roe et al. 1992). The initial conclusion one might be tempted to draw on the basis of this example is that vision is multiply realized; in normal ferrets vision is realized by activity in visual cortex, and in the rewired ferrets vision is realized by activity in their auditory cortex.

However, Polger and Shapiro point out that the activity in the auditory cortex of the rewired ferrets involves a reorganization of the brain tissue in the ferrets' auditory cortex so that its structure begins to resemble the structure in normal ferrets' visual cortex. Polger and Shapiro interpret these results as showing that the auditory cortex in rewired ferrets is able to realize vision in those ferrets because it takes on the same structures as those typically found in visual cortex. The visual capacities of the rewired ferrets were comparable to normal ferrets to the extent that the organization and connectivity of the reorganized auditory cortex resembled the visual cortex of normal ferrets. This leads Polger and Shapiro to suggest that what realizes vision in ferrets is a particular kind of structural organization of the neural cells in the cerebral cortex (Polger and Shapiro 2016, 97). Vision, for the rewired ferrets, is realized by columns of cells that are organized in approximately the same kind of retinotopic manner as normal visual cortex. The realizer of vision is not merely neural cells in a particular location in the brain. The location of the structure, whether it is found in visual cortex or in auditory cortex, is not relevant. Nor is the material individuative of the realizing kind. The extent to which the rewired ferrets possess visual capacities depends on the presence of the *same* neural structure as that

found in normal ferrets. Rewired ferrets can see to the extent that they possess the right kind of neural structure to realize vision, and the differences between vision in normal and rewired ferrets is explained by differences between the structures as they are realized by auditory or visual cortex. Insofar as vision in normal and rewired ferrets is the same, it is realized in the same way, and insofar as their vision differs, it is because their vision is realized differently. Based on this argument, Polger and Shapiro conclude that what appeared to be two kinds of realizers (activity in auditory cortex, and activity in visual cortex) should be unified and treated as a single kind (*Ibid*, 98). Vision is realized by activity in cortex with a certain kind of structural organization, and since there is only a single kind of structural organization that does the realizing in both normal ferrets and their rewired counterparts, there is only one kind of realizer for vision in ferrets, not multiple realizers.

3. 3. 2. Individual differences

The second strategy used by Polger and Shapiro to explain away some cases of multiple realization involves a different type of reason for unifying apparently different realizers under a single kind. In this case, the argument they make is based on the tolerance we have for variation within a kind. The general principle that informs Polger and Shapiro's individual differences strategy is that not *every* difference among realizers of a kind counts as a relevant difference. Merely pointing to a difference between two individuals that belong to the same kind does not suffice as evidence for the multiple realization of that kind. Let us assume, for the moment, that a kind, K, is individuated on the basis of a particular property, P. If K is multiply realized by two other kinds, K1 and K2, then K1 and K2 must both possess the relevant property, P. There must also be a difference between K1 and K2. Moreover, according to Polger and Shapiro, the difference between K1 and K2 that distinguishes them must be a difference that is relevant to the way K1 and K2 each realize P. This final clause captures the condition required by Polger and Shapiro that the difference between realizers of a kind be a relevant difference. Individual differences among members of a kind are excluded from counting as relevant differences.

The general lesson here can be illustrated by considering how different individuals

can belong to the same biological species. Among humans, for example, variability in height, weight, hair, eye colour, and many other features, are treated as irrelevant for belonging to the kind 'human'. This feature of the way that scientists accept differences among the kinds they study is important enough to Polger and Shapiro that is it included as a part of their recipe for multiple realization. The exclusion of individual variation as evidence of multiple realization is the forth condition in their recipe for multiple realization. Polger and Shapiro use this strategy against an example of multiple realization presented by Ken Aizawa and Carl Gillett (2009a; 2009b).

Aizawa and Gillett present an example of multiple realization based on differences in the way that human colour vision is realized. Among human beings, cones (one of two kinds of photoreceptor cells found in human eyes) can be composed of different types of proteins. According to Aizawa and Gillett the different kinds of protein chains that make up cones are capable of multiply realizing the same function that produces the phenomenon human vision. Aizawa and Gillett point out, for example, that there are two kinds of cones that are sensitive to red light, and given their role of being able to detect red light in human colour vision, this means colour vision in humans in multiply realized.

Polger and Shapiro spell this claim out in the detailed terms required by their account of multiple realization. They accept that the realization of trichromatic colour perception by different kinds of cones meets the first three requirements of their account. However, they argue it fails to meet the final condition. The variation among the proteins that make up the cones is the kind of variability tolerated within a kind by the scientists who study that kind (human trichromatic colour perception). When a distinction is drawn between different kinds of cones, that distinction includes differences not only in the composition of the cone, but also in the properties of the distinct cones. The two types of cones sensitive to red light (L-cones), named Red (ala^{180}) and Red (ser^{180}), can be distinguished not only on the basis of their composition, but also in terms of the range of visible light to which they are sensitive. So, in cases where the different kinds of cones are distinguished, their causal profiles are also distinguished. “Molecular differences among human S-opsins are reflected in differences among perceivers; and similarity of the perceivers is explained by the similarity of their S-cones.” (Polger and Shapiro 2016,

110)[64]

The Individual Difference strategy blocks uncharitable interpretations of identity theory. Individuals that belong to a kind need not have all their features in common and scientific ways to classify individuals sometimes allows for membership to be located along a continuum. None of these factors rule out the possibility that there are identities that hold between mental kinds and neural kinds. And more generally, membership to many scientific kinds allow for some flexibility of some of the features of members of that kind. The conditions for membership to a scientific kind present their own set of complex issues and I will only briefly touch upon them. In the next chapter, I raise an account of scientific kinds presented by Muhammad Ali Khalidi (2013). The Individual Differences strategy and the fourth part of the Polger and Shapiro's recipe gets something fundamentally right about tolerable variation within a kind, and places an important limit on what differences are evidence for multiple realization.

3. 3. 3. Kind splitting

I have already mentioned this strategy in my discussion of the grain argument. Kind splitting takes place when something that was taken to be a single kind is divided into two or more kinds. In cases of multiple realization there are always differences between one kind of realizer and another. So kind splitting cannot be deployed whenever there is a difference to which we can point between kinds of realizers, or multiple realization would be ruled out on conceptual grounds. Polger and Shapiro rightly accept that multiple realization is an empirical hypothesis, so the justification for kind splitting must be based on empirical considerations.

This illustrates a contrast between kind splitting and Shapiro's Dilemma. At the beginning of this section I said that the four strategies I discuss can be used to show that cases fall to one of the two horns of Shapiro's Dilemma. It would be circular to then use Shapiro's Dilemma to argue that examples of multiple realization involve detectable differences between the realizing kinds, and so the realized kind should be split to reflect

[64] Polger and Shapiro talk about the S-cones, which typically refer to cones sensitive to the shorter wavelength part of visible light, the blue end of the spectrum, but their discussion focuses on differences among cones sensitive to red light, which is sensed by L-cones. Both Red (ala180) and Red (ser180) are different kinds of L-cones (Kraft, Neitz, and Neitz 1998).

the differences among the realizers. And this is not the strategy pursued by Polger and Shapiro. They begin by observing that, "In particular, kind splitting seems to be accepted practice when what was thought to be a single psychological process is found to depend on multiple dissociable neural processes." (*Ibid*, 101-2) It does not suffice that the neural processes are dissociable though; the psychological processes must also be dissociable. This leads Polger and Shapiro to endorse a principle considered by Craver (2004), the *No Dissociable Realization* (NDR) principle.[65] What is important about the NDR principle is that the evidence for kind splitting is not primarily based on evidence about neural realizers, but rather on the evidence of dissociation between the psychological kinds. Dissociations between neural correlates of psychological processes can be used as supporting evidence in favour of dissociating the psychological kinds, but it rarely suffices on its own.[66] Craver provides the follow description of dissociation,

> In cases of dissociation, we are able to identify two or more distinct sets of relevant entities, properties, and/or activities, one set for each of two or more *independently detectable realized kinds* [emphasis added]. The parts, properties, and activities that we appeal to in explaining procedural memory are not at all relevant to explaining declarative memory and vice versa. (Craver 2004, 970)

The part of Craver's quote that I emphasize highlights that evidence for dissociations between psychological kinds should involve differences between those psychological kinds as well as neural differences.

The example of how memory has been subdivided into its many different sub-

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[65] It is worth noting that Craver himself rejects the NDR principle as a universal constraint on the realization of psychological kinds. Polger and Shapiro mistakenly claim that Craver takes NDR to be a general principle in psychology, e.g., "And Craver argues that the *No Dissociable Realization* is widely endorsed by psychological and brain sciences, citing both philosophers and psychologists," or "As we've noted, if Craver is right then the discovery of dissociable realizers is sufficient for kind splitting." (Polger and Shapiro 2016, 103) This interpretation is clearly at odds with the conclusion Craver himself draws, "The problem of dissociable realization is to come up with a principled way to restrict NDR to only those cases in which it is truly appropriate. Here I have identified a range of cases in which NDR arguably fails. These different cases correspond to different varieties of realization at work in contemporary cognitive neuroscience." (Craver 2004, 970)

[66] Craver proposes additional features that are important when deciding whether to distinguish realized kinds or not, "In this case, failure to find an intelligible way to distinguish two realized phenomena by attention to their contextual or etiological realizers may trump the discovery that the constitutive realizers are dissociable. Each example illustrates that our willingness to split kinds extends only to those cases in which it is possible to distinguish them contextually and etiologically as well." (2004, 967)

kinds – the example Polger and Shapiro use to illustrate their strategy of kind splitting – involves the right kind of differences among psychological kinds and their correlated behaviours to justify splitting memory into its various sub-kinds (e.g., procedural memory, epistemic memory, autobiographical memory, etc.). Establishing what the right types of differences are for a psychological kind to be split is relative to the psychological kind as it is individuated. The differences between kinds of memory include double dissociations between behavioural measures related to the psychological kinds and between the brain areas thought to be the realizers of the relevant psychological kinds. On this basis Polger and Shapiro conclude, "Dissociable realizers are not examples of same-but-different, they are yet again examples of different-and-different." (Polger and Shapiro 2016, 104). This is the right conclusion to draw with respect to cases where psychological kinds have different characteristic features that can be identified, measured, and investigated. But the justification for kind splitting will be piece-meal, there is no general rule for deciding which differences within a psychological kind will be discovered to be dissociable and which are not. In my discussion of language related psychological abilities, I argue that these kinds of differences are not found. As such, kind splitting does not systematically undermine the possibility of multiple realization, rather it again points to the fact that multiple realization is determined empirically.

3. 3. 4. Abstraction and idealization

The last strategy I discuss is different from the previous three. In the same way that the grain explanation was advanced by Bechtel and Mundale to explain the mistaken confidence in multiple realization, Polger and Shapiro argue the practices of abstraction and idealization in the mind and brain sciences explain how mismatches between grains of description of psychological kinds and neural kinds take place. In this section I briefly describe what abstract and ideal kinds are and the role they play in explanations in the mind and brain sciences. I then present Polger and Shapiro's view that credence in multiple realization is the result of mistakenly interpreting the explanatory practices of abstraction and idealization as carrying ontological implications.

Explanations of psychological phenomena sometimes use computational or

theoretical models. These models sometimes include reference to abstract or ideal kinds. Following John Norton (2012), a model and the kinds that appear in it are abstract if the model represents the target phenomenon, phenomena, or system inexactly, whereas a model is an idealization if the model is an exact description of a fictional system (Norton 2012). Creating an abstraction involves leaving out certain details that are thought to be less important (or unimportant) to the behaviour of the target phenomenon. On the other hand, an idealization is a complete, but fictional, system that resembles the target system, but which includes additional features that are not part of the target system. Polger and Shapiro distinguish abstraction and idealization in a similar manner,

> Where abstraction is typically characterized in terms of removing or subtracting information from an explanation or model, idealization is characterized in terms of adding information – particularly information that is thought to be in some way inaccurate or false. (Polger and Shapiro 2016, 182-3)

Either by omission or addition, models that involve abstraction or idealization deliberately involve features that are unlike the features of the actual world. Abstract or ideal models are unlike the world in some way, yet they are used successfully to explain features of the world. A problem arises, according to Polger and Shapiro, when the success of abstract or idealized models leads to postulating the existence of abstracted or idealized kinds, abstracta, that appear in the models. They call this strategy 'Postulation'. Polger and Shapiro argue that functionalists typically accept Postulation as the explanation for the success of abstraction or idealization in the sciences. They argue that Postulation is a mistaken strategy, however, because abstracta do not belong to the ontology of the actual world. Abstracta serve epistemic purposes, but it is a mistake to interpret their role in successful explanation as providing evidence regarding the ontological kinds present in the world.

On the basis of this reasoning, Polger and Shapiro argue that in some cases the mismatch between the grains of description of psychological kinds, and biological or neurological kinds is because psychological kinds are sometimes abstracta. Polger and Shapiro use 'perception' as an example of an abstract kind in psychology. There is no specific psychological capacity 'perceiving', but rather many different capacities that

share certain general features (Polger and Shapiro 2016, 183). Abstraction involves removing or ignoring certain details about particulars and treating them as having the uniform properties of a more general kind, "On the view we're outlining, when psychological and neuroscientific taxonomies fail to align, the reason will sometimes have to do with the presence of abstract or idealized kinds in the former." *(Ibid,* 186) The difference between taxonomies is due to the imperfect way that abstractions or idealizations represent the world. Psychological kinds involve abstraction or idealization, because those kinds figure in the explanatory practices in psychology. The success of explanations that appeal to abstracta gives abstracta a legitimate place in explanatory practices, but does not lead to their inclusion in our ontology. Since a kind must be realized, i.e. made to exist in virtue of its realizer, to be a candidate for an example of multiple realization, abstracta are non-starters for Polger and Shapiro. Abstracta are not multiply realized, because abstracta, on Polger and Shapiro's view, do not exist.[67]

3. 4. Summary

In this chapter I summarized two arguments against multiple realization, the Grain Argument and Shapiro's Dilemma. I argued that neither was successful as a general argument against the possibility of multiple realization of mental kinds. However, both arguments could be re-framed as ways to call into question particular instances of multiple realization. Narrowing the scope of these arguments to apply only to instances of multiple realization provides an indirect way of arguing against multiple realization. If apparent cases of multiple realization can be explained away by defeaters, then our overall confidence in the possibility of multiply realizable mental kinds should decrease. These defeaters cannot show that multiple realization is not metaphysically or conceptually possible, but they might show that multiple realization is vanishingly rare.

I presented four strategies used by Polger and Shapiro as defeaters of instances of multiple realization: unification, individual differences, kind splitting, and abstraction and

[67] Christopher Viger (2000) proposes a different way to understand the role that abstracta play in psychological explanations. He argues that abstracta should be granted ontological status based on their role in successful explanatory practices. I return to his argument in the next chapter, §4.2., when I offer a reply to Polger and Shapiro's view that many psychological kinds are merely abstractions, and so not candidates for multiple realization.

idealization. Each strategy presented reasons for denying that apparent cases of multiple realization count as genuine examples of multiple realization. These strategies are used to object to cases of multiple realization based on empirical evidence from neuro- and cognitive science. The use of empirical case studies to support or deny the occurrence of multiple realization is a departure from the original manner in which the argument from multiple realization was presented.

One of the key points Polger and Shapiro make is that not any difference between realizers suffices to establish an example of multiple realization. They employ the slogan that only instances where various realizers are 'differently the same' are genuine cases of multiple realization. A useful process in determining whether two realizers are differently different, samely the same, or differently the same, is being able to decompose what features of a realizing kind are relevant to the realization of a property in question. To discover what the realizers of a property are, and to assess whether those realizers differ relevantly from each other, it is useful to have an account of realization that makes it clear what the realizers of the property in question are.[68] Having an account of realization ready to hand might also shed some light on where one might look for the taxonomies that contain kinds that are candidate realizers or candidate properties to be realized. There might also be some indication as to the explanatory roles those kinds play within the relevant taxonomies. This would aid in putting questions about potential cases of multiple realization into a specific and contrastive context, as Polger and Shapiro require. The evidence for and against cases of multiple realization in this chapter appealed to empirical studies, which underscores the importance of the second desideratum I defended in the introduction; it must be possible to assess examples of multiple realization using empirical evidence. The details about particular case studies matter in determining whether or not one is looking at a genuine case of multiple realization.

In the next chapter I present three examples from the cognitive neuroscience of

[68] Polger and Shapiro argue that realization can only be explained by supplying an account of what it means for a kind to be multiply realized. They comment, “So, realization is a synchronic ontological dependence relation, distinct from identity, that transmits physical legitimacy from physical realizers to what is realized. And finally, whatever is realized must be multiply realizable.” (Polger and Shapiro 2016, 22) As my discussion in the introduction and first chapter illustrate, many other authors have advanced accounts of realization before attempting to settle questions regarding multiple realization.

language of multiple realization and argue that these examples cannot be explained away using the strategies outlined in this chapter. In all three of the case studies I present in the next chapter I appeal to empirical studies for evidence that the mental kinds in question are multiply realized. I argue that language, broadly construed, reading, and bi- or multi-lingualism are each multiply realized.

Chapter Four: Examples of multiple realization from the cognitive neuroscience of language

4. 1. Introduction

In this chapter, I present three examples of multiple realization. I argue that each case avoids the objections outlined in the previous chapter. All three cases are, I argue, empirically discovered instances of multiple realization from research in the cognitive neuroscience of language.

To develop the view that these cases are genuine examples of multiple realization I apply Shoemaker's account to describe the realizers of the relevant mental kinds. In doing so I illustrate how the examples I offer conform to the desiderata I defended in the first chapter. As a remind, the desiderata I defend are:

1. The realization relation should support physicalism;
2. Whether a mental kind is multiply realized should be decided on empirical grounds;
3. The account of realization should avoid the causal exclusion problem.

Applied to the specific cases this means that, (1) the realizers identified in the examples should all be entities that are acceptable in a physicalist ontology, (2) the evidence of differences among realizers should be collected using empirical means, and (3) the examples should not introduce problematic kinds of causal overdetermination. As I showed in the second chapter, Shoemaker's account of realization meets the desiderata. So, as long as the examples in this chapter conform to Shoemaker's account, the examples I develop in this chapter should be viewed as being in good standing. With regard to the first two desiderata, and without entering into the details, the cases are in a good position to meet the desiderata. They are examples that are drawn from contemporary research in cognitive neuroscience, so the entities referred to are acceptable to a physicalist ontology. And the examples all come from empirical research, so the evidence for or against them counting as cases of multiple realization meets the second desideratum. As I argued in the second chapter, Shoemaker's account of realization avoids the causal exclusion argument, so if the examples fit his account, then the third desideratum is also met.

To support my view that these are genuine cases of multiple realization I also argue that the examples meet the criteria for genuine cases of multiple realization advanced by Polger and Shapiro (2016). In this chapter I am focused on assessing whether particular case studies are examples of multiple realization, so the desiderata used to assess an account of realization is a step removed from being directly applicable to assess these examples. In addition to being more directly applicable to the examples, I focus on arguing that the examples meet P&S's criteria to avoid any changes that my defense is either question begging or that the examples in this chapter are somehow cherry-picked to conform to Shoemaker's account of realization. Shoemaker's account of realization is useful in demonstrating how the mental kinds being researched are realized by the physical kinds identified in the course of that research, but its application to the cases will not demonstrate that there are multiple different realizers. Shoemaker's account is a general theoretical account of the realization relation, so applying the account to show that the examples conform to an account of realization establishes them as candidates for interpretation as examples of *multiple* realization. To defend the position that the examples include multiple distinct realizers of the same mental kind, I demonstrate how these examples meet the conditions P&S place on cases of multiple realization. I directly address the defeaters from the previous chapter that are relevant to the cases of multiple realization in this chapter. The conditions P&S advance apply specifically when assessing candidate examples of multiple realization. Since P&S are skeptical that there are genuine cases of multiple realization, finding cases that meet the conditions they advance will not be a trivial matter.

I begin by discussing language lateralization. I use this example to show that language treated as a broadly specified kind, despite a long history of localization of language to certain regions of the brain, is multiply realized. Second, I discuss models of reading. This example looks at a finer grain of description than the previous case. I look at how reading, as a cognitive capacity, is acquired and how different types of teaching/experience can result in acquiring the same capacity. This example raises the possibility that different etiologies of the same kind may result in a case of multiple realization. The third example I discuss elaborates on the importance of the etiology of a

psychological kind. To illustrate how different etiologies can result in different realizers for the same psychological kind I discuss research on bilingualism and multilingualism. I use these examples to argue that when a psychological capacity is acquired by different individuals in different ways it can lead to relevant differences in the realization of that capacity.

4. 2. Language lateralization

I begin with the well-known case of language lateralization. Language lateralization is a description of the degree to which one cerebral hemisphere has a greater amount of neural activity during language related tasks than another. Greater activation can be measured in several ways. Comparisons between the amount of active neurons (or voxels) in the right and left hemisphere, the amount of activation in particular areas within the right and left hemispheres, the peak activation levels in the right and left hemispheres, or the discovery that a region in the right (or left) hemisphere is active while the homologous region in the opposite hemisphere is not can all be used as evidence that one hemisphere is more involved in language processing than the other. The differences in these comparisons between left and right hemispheres have led to localization claims about where in the human brain language is processed.[69] The consensus is that, in the majority of cases, language is lateralized so that the left hemisphere is dominant. However, it is vital to keep in mind that claims about hemispheric dominance are claims about the *relative* degree of activation when the right and left hemispheres are compared. *Both hemispheres are active during language tasks*, it is only that in most cases the left hemisphere appears to be more engaged in those processes compared to the right hemisphere. Lateralization is matter of degree of difference in activation, and so there is a continuum along which hemispheric dominance can be expressed.

Localization claims regarding the source of our language abilities are some of the earliest achievements in neuroscience. The discoveries of Broca's area (Brodmann areas 44 and 45) and Wernikie's area (Brodmann area 22) through the post-mortem study of the

[69] Evidence of greater language related activation in the left hemisphere comes from a variety of different sources, including studies that use fMRI, direct cortical stimulation, and behavioural and anatomical analysis of individuals with aphasia.

brains of patients with language deficits, laid the foundation for the view that our language abilities are supported primarily by structures in the left hemisphere of our brains. Evidence that language is lateralized to the left hemisphere of most humans' brains has been collected using inhibitory drug testing (primarily by the WADA test, see Tröster and Mohn 2008 for a summary of the use of this test), and more recently by neuroimaging studies using fMRI (e.g. Desmond et al. 1995; Vikingstad et al. 1999). However, while the majority of people demonstrate left hemisphere lateralization, there is a minority of individuals whose brains show a different pattern of lateralization. For some, their language abilities are localized primarily on the right-hand side of the brain, rather than the left, in a kind of mirror image of normal cases. The frequency of the right hemisphere lateralization is higher in left-handed individuals than for right-handed people (Knecht et al. 2000; Springer et al. 1999; Szflarski et al. 2006; Pujol et al. 1999; Szflarski et al. 2002; Szflarski et al. 2012). In addition to the reversal cases, there are also cases in which there is no dominant hemisphere; instead, activation is more evenly distributed bilaterally (Jones et al. 2011; Pujol et al. 1999; Springer 1999; Szaflarski et al. 2002; Szflarski et al. 2012). The degree to which language is lateralized for a particular individual is located on a continuum from strongly left hemisphere dominant to primarily right hemisphere dominant (of course, with the cautionary reminder that both hemispheres are active during language tasks, lateralization is the expression of the degree of difference in levels of activation).

Given the kinds of variation we see with respect to language lateralization, I contrast two cases. First, I consider whether we should think of cases where language is lateralized on the right side of the brain, in a reversal of the common left side lateralization, as a case of multiple realization. I argue that this counts as weaker evidence for language being multiply realized, since the mirrored brain states could reasonably be considered type identical to typical cases of language lateralization. In contrast to this, I look at the cases where the localization is not simply reversed. Cases where there is bilateral distribution of activity make a stronger case for multiple realization. The bilateral distribution is unlike right hemisphere lateralization, where there is a simple isomorphism between left-hemisphere dominance and right-hemisphere dominance. There is no

obvious isomorphism when the activation is bilaterally shared, and so such cases will count as relevantly different realizers to the common left hemisphere lateralization, and to the cases of mirrored lateralization on the right side.[70] Once I contrast these cases, I discuss how there can be changes in language lateralization in an individual over their lifetime. I conclude the section by considering how recovery from a stroke (or other brain infarction) can alter language lateralization, and how this type of change, as an example of neuroplasticity, may in some cases be counted as an example of multiple realization, while other cases are properly explained away by the grain argument.

In most human beings there is greater activation in the left-hemisphere of their brain while they are engaged with activities involving language. Such activities include reading, writing, and the comprehension and production of speech. The asymmetric activation in the brain with respect to language has been known for over a century. It must be noted that the language lateralization does *not* imply that there is no activity in the right hemisphere during language related activities. Left hemisphere dominance should be understood as indicating only that there is *greater* activity in the left hemisphere on average. Lateralization is a matter of difference in the degree of activation in the left hemisphere compared to the amount of activity in the right hemisphere (Vikingstad et al. 2000; Jones et al. 2011). Nevertheless, the difference in relative activity is strong enough that the localization of language is taken as a guide in many areas in the mind-brain sciences, including as an important consideration during neurosurgery (Desmond et al. 1995; Jones et al. 2011).

Through the use of functional neuroimaging it is estimated that between 90% to 95% of the right-handed population has left hemisphere lateralization (Knecht et al. 2000; Springer et al. 1999; Szaflarski et al. 2006).[71] Left hemisphere lateralization is less

[70] The lack of anatomical symmetry in such cases is suggestive of relevant differences in brain states. How we are to specify which differences are relevant to a question, and which differences can be dismissed, is a complex question. Ultimately, I argue that what counts as a relevant difference will be a matter of the research questions being asked, and the cases that are being contrasted. There cannot be an *a priori* way of settling which differences are relevant before closely looking at the research program where these differences are being investigated. I return to a discussion of what makes a difference relevant in later sections and in the fifth chapter I propose a view where mechanisms are taken to be the realizers of functionally individuated mental kinds.

[71] I base the estimates of lateralization in right-handed individuals on studies by Knecht et al. 2000, Springer et al. 1999, and Szaflarski et al 2006. The Knecht et al. 2000, Springer et al. 1999, and

frequentin left-handed individuals, where estimates vary between 78% to 85% of test individuals showing left hemisphere language lateralization (Pujol et al. 1999; Szaflarski et al. 2002; Szaflarski et al. 2012).[72] The percentages of left and right hemisphere lateralization in both right-handed and left-handed individuals are all approximate numbers. I want to highlight that the frequency of atypical language lateralization in both right-handed and left-handed individuals was not known prior to the neuroimaging studies. There are no behavioural cues that distinguish individuals with left hemisphere dominance from those who have right hemisphere dominance or bilateral activation. This

Szaflarski et al. 2006 studies looked at large numbers of healthy right-handed individuals. Knecht et al. (2000) used fTCD (functional transcranial Doppler-ultrasonography) to determine the language lateralization of 188 right-handed German speaking participants. Participants performed a silent word generation task in response to a visually displayed letter. 174 of the 188 participants showed left hemisphere lateralization. The remaining fourteen participants were classified as right hemisphere dominant, though the study did not distinguish right hemisphere dominance from bilateral activation. Springer et al. (1999) used fMRI to study language lateralization in 100 healthy right-handed individuals and fifty right-handed individuals with epilepsy. Participants were presented aurally with the names of animals and asked to press a button if the animal was found in the United States and was used by humans. All participants spoke English. Participants were classified as left hemisphere dominant, right hemisphere dominant, or symmetric activation. Ninety-four of the 100 healthy participants showed left hemisphere dominance, and six showed symmetric activation. None were right hemisphere dominant. Among the fifty participants with epilepsy thirty-nine were left hemisphere dominant, three were right hemisphere dominant, and eight had symmetric activation. Szaflarski et al. (2006) used fMRI to scan one hundred and fifteen children (ages 5-17) and fifty-five adults (ages 18-67) while participants performed a silent verb generation task in response to aurally presented nouns. Of the 170 participants 161 showed left hemisphere dominance. There was no difference in the proportion of left-hemisphere lateralization between the children and adults, though there are differences in the extent to which language is lateralized between children and adults. Szaflarski et al. (2006) found that lateralization increases until it reaches a peak at around twenty-five years old, and then decreases from that point onward.

[72] I base the estimates of lateralization in left-handed individuals on studies by Pujol et al. 1999, Szaflarski et al. 2002, and Szaflarski et al. 2012. Pujol et al. (1999) contrasted the lateralization of fifty right-handed individual with the lateralization of language in fifty left-handed individuals. Among the left-handed participants thirty-eight showed left hemisphere lateralization, five had language lateralized in the right hemisphere, and seven had bilateral activation. By contrast only two right-handed individuals had bilateral activation and none showed right hemisphere lateralization. Participants in the study spoke either Spanish or Catalan. Participants were presented with a letter (F, A, S, C, D, M, P, and R) and were asked to silently generate words beginning with that letter. Szaflarski et al. (2002) investigated the lateralization of fifty left-handed or ambidextrous individuals. Participants spoke English and performed the same task as in Springer et al. (1999) Of the fifty left-handed or ambidextrous participants thirty-nine showed left hemisphere lateralization, four had right hemisphere lateralization, and seven individuals showed bilateral activation. Szaflarski et al. (2012) looked at language lateralization in left-handed children (ages 5-18). Participants performed the same verb generation task as in Szaflarski et al. (2006). Left hemisphere lateralization was found in 23/27 participants, 3/27 had bilateral activation, and one participant showed right hemisphere lateralization. In contrast, when Szaflarski et al. (2012) scanned fifty-four age matched right-handed children 50/54 had left hemisphere dominance, 3/54 showed bilateral activation, and 1/54 had right hemisphere dominance.

suggests a prima facie reason to take language lateralization as an example of multiple realization. The same psychological kind, human language, is realized differently in different individuals.

To assess whether the different ways in which language can be lateralized count as an example of multiple realization, I apply Shoemaker's account of realization to describe the case study. The property being realized is general language abilities, which includes the forward looking causal powers of comprehending and responding appropriately to oral or written language. The causal powers include being able to think about and report words that belong to particular semantic categories (e.g., listing names of animals kept as pets in North America), words that share similar written features (e.g., listing words that begin with a prompted letter), or words that are semantically and grammatically related to a prompt (e.g., listing verbs that are semantically related to a prompted noun). The forward-looking causal powers are, in this case, a broad range of capacities related to language comprehension and production. The backward-looking causal powers are equally broad, as they include responsiveness to both oral or written prompts, but also the ability to speak and understand the language, training on the particular task, and a myriad of other physical and psychological preconditions that must also be satisfied.

Turning now to the realizer(s) of the mental kind, the distinction Shoemaker draws between the core realizer of a property and its total realizer is of use in describing how a complex property, such as the general language capacity in this example, is realized. Starting with the total realizer, an individual must be able to hear or see and read the prompt, attend to the prompt and the instructions for the task, remember or recall the instructions and appropriate words to answer the prompt, and the individual must be capable of producing responses verbally, sub-vocally, or indicating a response by pressing a button. Each of these abilities requires many different physical features to be realized: for example, to hear one must have ears, there must not be too much outside noise that interferes with auditory perception, and there must be activation in the auditory cortex. Or to read a prompt one must have eyes, proper lighting, and there must be activity in visual cortex.[73] None of these mental capacities or the physical systems that realize them are the

[73] I am here describing physical events that take place during the tokening of a particular individual's

core realizer of the general language property. The core realizer is distinct from the motor capacities required to speak or to press a button, it is distinct from the perceptive capacities required to hear spoken words or to see written words. The core realizer has to do with the specifically language related abilities of understanding the meanings of words, and relating those meanings to the meanings of other words.[74] So, the core realizer is the network of areas in the brain that are most active when an individual is engaged in language specific tasks, contrasted with tasks that are not language specific but which may nevertheless be part of the total realizer of the language specific task. In individuals with left hemisphere lateralization, the brain areas most active are found in the left hemisphere of the brain, primarily in Broca's area and Wernicke's area (Brodmann areas BA44 and BA45, and BA21, BA22, BA 41, and BA42, respectively), as well as the connective neural tissue between those regions (Binder et al. 1997); for individuals with right-hemisphere dominance, the same brain areas (Broca's and Wernicke's area, etc.) on the right hemisphere have greater activation; and for individuals that don't exhibit hemispheric dominance, the same brain regions in both the right and left hemispheres are approximately equally active.[75] So, in the three different cases there is the potential for three distinct kinds of core realizers: activation in the language network with more activity in the left hemisphere, activation in the language network with more activity in the right hemisphere, and evenly distributed activation in the language network across both hemispheres.

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response. I do not intend to imply that any of the particular physical features enumerated in the examples are necessary in a logical, metaphysical, or nomological sense. I mean that in particular instances that involved the particular participants in the experiments these features were all present and required for those participants to perform the relevant tasks. The enumerated features are not necessary in the sense that the mental property being investigated could not occur without them; whether or not that is possible is what is presently at issue.

[74] Disentangling the boundaries between what the core realizer and those features which belong only to a total realizer becomes increasingly difficult with complex properties (Ardila, Bernal, and Rosselli 2016). One useful tool that can aid in isolating a core realizer is research into double dissociation. Discovering how to interrupt *only* language while leaving other capacities intact is an important tool in separating a core realizer from the other feature that make up the total realizer. Bechtel's (2007) analysis of how scientists decompose a phenomenon and localize particular activities to specific sub-components of a mechanism is of use in distinguishing the core realizer of a property.

[75] These macroscopic physical systems and the activities that they perform will, of course, be made up out of micro-entities that are engaged in other particular activities. So, on Shoemaker's account of realization instances of the relevant property will each have an MSE-property that picks out the particular microphysical entities that realize that instance.

Though individuals can be grouped into three broad camps, left hemisphere lateralization, right hemisphere lateralization, and bilateral or symmetric activation, language lateralization comes as a matter of degree. The variability of the degree of lateralization for individuals with left hemisphere lateralization could be treated as a kind of Individual Variability that Polger and Shapiro deny counts as evidence for multiple realization. But right hemisphere lateralization or symmetric activation cannot be dismissed as merely variability within the population. There is a limit to what can be counted as Individual Variability, and the complete reversal of the typical pattern of lateralization goes well beyond those limits. But, Polger and Shapiro (2016) present an example that may count as a relevant parallel with the example of language lateralization. They present the case of *situs inversus viscerum*, anatomy. So, for example, individuals with *situs inversus* have their heart located on the right side of their body and their liver on the left. Polger and Shapiro then ask whether a *situs inversus* heart (SI-heart or generally SI-organs) counts as a different realization of a heart from typically located hearts. They conclude that it does not, because the location of the heart is not relevant to the individuation or functioning of the heart *as a heart*. The differences are not differences that make a difference, and so SI-organs fall to the first part of Shapiro's dilemma.

Individuals who have language lateralized on their right hemisphere of their brains might be thought of as being similar to individuals who have their hearts located on the right side of their body. These differences are important medically, but they do not make a difference to the functioning of the organs themselves. So, by the same reasoning Polger and Shapiro apply to *situs inversus viscerum*, atypical language lateralization to the right hemisphere of the brain should not count as an example of multiple realization. For this comparison to be appropriate the presumption is that cases of right hemisphere dominance are mirror reversals along the corpus callosum of the typical cases of left hemisphere dominance. However, even if this is granted, there is reason to suspect that there are relevant disanalogies between *situs inversus* organs compared to normal organs and right hemisphere lateralization and left hemisphere lateralization. The first point I wish to draw attention to is that *situs inversus* involves the reversal of all the organs in the

thorax and abdomen, whereas right hemisphere dominance is not necessarily accompanied by the reversal of other lateralized cognitive abilities (Josse et al. 2008; Josse and Tzorio-Mazoyer 2004; Perlaki et al. 2013). Of course, there are anatomical differences, but the differences are not symmetical as in *situs inversus*. Assuming that the connectivity between brain areas that form functional networks is an important aspect of how cognitive or psychological kinds are realized, there will be differences in the connections for individuals with right hemisphere lateralization and those with left hemisphere lateralization.

The second point of disanalogy between *situs inversus* and language lateralization is that language lateralization comes in degrees and *situs inversus* does not. This is most evident when considering cases where individuals have bilateral activation. In such cases neither hemisphere is dominant with respect to language processing. Bilateral activation is more common than right hemisphere lateralization in both right-handed and left-handed individuals. In cases where an individual shows symmetric activation in both their left and right hemisphere with respect to language, there is no dominant hemisphere. In such cases there is no way of describing bilateral activation as a reversal of normal cases. Moreover, unlike our organs' locations (whether those organs are SI-organs or not), language lateralization changes over an individual's lifetime.[76] (Cabeza 2002; Szaflarski 2006) The degree of language lateralization in an individual, known as the lateralization index (LI), changes progressively over an individual's lifetime, but can also be radically impacted by a stroke and subsequent recovery (Szaflarski et al. 2014; Saur 2006). These aspects of language lateralization are relevant dissimilarities to the *situs inversus* example presented by Polger and Shapiro. Differences in individuals' lateralization indices cannot be unified as all belonging to the same kind, so language lateralization cannot be dealt with using Polger and Shapiro's Unification strategy.

[76] Though it is generally accepted that language lateralization changes over an individual's lifetime, with the lateralization index (LI) increasing over the first twenty-five years of life, then slowly decreasing after that point, new evidence suggests that this pattern is not universal (Nenert et al. 2017). Nenert et al. (2017) present evidence that changes to an individual's LI are affected by an individuals' handedness and sex, leading them to argue against the HAROLD model (the HAROLD model is presented by Cabeza (2002). HAROLD is a shortened name for the 'hemispheric asymmetry reduction in older adults model'). The pattern of decreasing LI applies to right-handed men, but does not universally generalize (Nenert et al 2017).

However, perhaps Polger and Shapiro can use the strategy of dividing and conquering. Right hemisphere lateralization when compared to typical left hemisphere lateralization may not count as evidence for multiple realization because there are not relevant differences among the way that individuals with right hemisphere dominance realize their language abilities compared to individuals with left hemisphere dominance. To deal with cases of symmetric activation, Polger and Shapiro could instead appeal to their strategy of Individual Differences. The extent to which an individual has language lateralized to one or the other hemisphere varies along a continuum. This might lead one to conclude that symmetric activation is at one end of this continuum and strong left hemisphere activation at the other, but that this variability is an example of the expected kind of variability among individuals. While I do not want to deny that there are fuzzy boundaries between left hemisphere dominance and symmetric activation, I do not think that this alone justifies treating cases of symmetric activation as a kind of limit case of individual variability in language lateralization. Grouping together individuals with bilateral activation and individuals with varying degrees of left hemisphere dominance, but leaving out individuals with right hemisphere dominance seems arbitrary. And including individuals with right hemisphere dominance as merely cases of individual variation within a population is as mistaken as treating *situs inversus viscerum* as being just individual variation within the population. Doing so would, in effect, be acting as though the hypothesis that mental kinds are not multiply realized is unfalsifiable.

This leaves two remaining strategies, kind splitting, and abstraction and idealization. One might think that language lateralization fails to count as an example of multiple realization because language is a disunified category like memory. There is merit to this concern. Treating language as a single cognitive ability would be misguided. Language involves many different capacities, including producing speech, understanding spoken language, or understanding written texts. Understanding speech or reading each involve their own sets of different demands. But the different psychological kinds into which we might want to divide language would leave differences between individuals with typical and atypical language lateralization untouched. To explain away language lateralization as an example of multiple realization would require us to split left

hemisphere dominant language users, right hemisphere dominant language users, and symmetric activation language users into different kinds of language users. But, as I noted earlier, there are no behavioural indicators for hemisphere dominance. So, the only evidence for splitting these groups into different kinds is the neural differences, and such a difference is not adequate justification for kind splitting.

Talk of splitting psychological kinds associated with language brings up a different concern. There is a general challenge, raised by Sullivan (2010), about how psychological kinds are individuated in laboratory settings. The different choices of tasks by different labs, or by the same lab at different times, is problematic. As Sullivan (2010) points out, the use of different protocols raises the concern that different, but overlapping, phenomena, rather than a single phenomenon, are being investigated. There are a variety of tasks used to assess language lateralization. The differences between methods for eliciting language related activation in the different studies could be viewed as evidence that there are different phenomena being investigated. By lumping the different studies together and counting them as studies of language lateralization it could be that I have moved from one grain of description to another, and thereby run afoul of the grain argument. One might think that each case of language lateralization via a different task should be described as such, so that there is language-as-tested-via-silent-verb-generation-in-response-to-aurally-presented-nouns lateralization and language-as-tested-via-silent-word-generation-in-response-to-visually-presented-letters lateralization. But giving these more precise descriptions mistakes the goals of the studies. In none of the studies that I cited regarding language lateralization were there any claims regarding the localization of a specific ability. The different tasks were selected as general ways of eliciting language related activation. Task performance was not a measure that was taken as relevant to the degree or location of neural activity. Levels of activation in the whole brain were collected and used to assess the extent to which language was lateralized in the participants.

Abstracting away from the specific tasks to look at language as a broadly construed psychological capacity brings up the final strategy deployed by Polger and Shapiro, abstraction and idealization. This strategy raises the question, have I mistakenly

added an entity to the ontology of psychological kinds in treating language lateralization as an example of multiple realization? Questions regarding the ontological status of language or languages are complex and run orthogonally to the question of whether the psychological kinds associated with language I have been discussing here are abstracted or idealized in certain ways. To answer this question satisfactorily would require far more time and space than I can dedicate to the issue here. I think it is better to side step attempting to settle or even speculate on the ontological status of language.

To avoid the charge that the phenomenon investigated by studies of language lateralization is merely an abstraction or idealization it is enough to look at what researchers of language take themselves to be investigating. In their discussion of abstraction and idealization Polger and Shapiro are particularly concerned that aspects of computational models used in psychology and cognitive science are reified illegitimately. Language lateralization is not a feature of a computational model, is it an abstraction of a different kind, and so does not fit this allegedly problematic pattern. The studies are aiming at a general cognitive ability that involves perceiving, processing, understanding, and responding to aurally or visually presented words. The responses to the presented words required participants to be aware of semantic features of aurally presented words (e.g., the task where individuals had to identify whether an animal was used by humans and located in the United States) or orthographic features of visually presented words (e.g., the task where individuals listed words that began with a cued first letter). The studies abstract away from some factors, such as the number of words a given individual produces or features that are relevant to preforming the task. But this kind of abstraction does not problematically introduce extra entities into our ontology. The fact that there are many ways that we are sensitive to language, and so many different tasks can be used to elicit language related neural activity, should not count against thinking that there exists a general cognitive or psychological kind, language, that can be lateralized.

Using the example of perception Polger and Shapiro express the worry that general superordinate psychological categories are merely abstractions or idealizations, but broad or superordinate categories play roles in most scientific taxonomies; atoms,

mammals, isotopes, or stars all group together diverse subordinate kinds.[77] There should be nothing more suspicious about broad or general categories when they appear in psychology, cognitive science, or neuroscience than when they appear in chemistry, physics, or biology. Moreover, as the grain argument points out, the grains of descriptions of a phenomenon and its realizer(s) should match. Hemispheric dominance and responsiveness to language are both coarse grained descriptions of neurological and psychological phenomena, respectively.

This leaves the concern that superordinate categories in any scientific field are to be viewed with ontological scepticism. Such scepticism or anti-realism has a long pedigree in the philosophy of science, as Polger and Shapiro acknowledge (Polger and Shapiro 2016, 184). But it is not the only available view, and not the one that Polger and Shapiro themselves favour. Rather, Polger and Shapiro defend a view they call 'Settle',

> In Settling, we accept the explanatory necessity of such kinds [abstract or idealized kinds], while denying that they demand an analysis that requires that they be "filled in" with multiply realized entities. Abstraction and idealizations are features of our ways of representing the world rather than aspects of the world itself. (Polger and Shapiro 2016, 186-87)

This general view relegates kinds that involve abstraction or idealization to playing a purely epistemic role in scientific explanations. Representations that involve abstraction or idealization belonging to one discipline's taxonomy will not always line up with the kinds used in another discipline's taxonomy. Polger and Shapiro think that defenders of multiple realization over-interpret this and draw ontological conclusions, positing the existence of multiply realizable abstract or ideal kinds. Polger and Shapiro view this as going too far. For them the evidence supports drawing conclusions only about our epistemic practices in the sciences. This leads Polger and Shapiro to acknowledge that their argument may be a general indictment of Realism (*Ibid*, 187).

In the previous chapter, §3.3.4., I noted that Polger and Shapiro reject Postulation as an acceptable account of the ontological status of abstracta. To reject Postulation they

[77] Muhammad Ali Khalidi (2013) defends the legitimacy of approaching virus, isotope, and fluid (Newtonian fluid) as natural kinds. Khalidi sees natural kinds as being bound together by shared causal properties among members of that kind. These shared causal properties allow for scientists to make predictions; natural kinds are projective.

appeal to the view that our use of, and appeal to, abstract entities in some explanatory contexts is a feature of our psychology. Our use of representations only imperfectly describes the world. For the remainder of this section I revisit the viability of Postulation, and ague that there are reasons to accept Postulation despite the arguments against it Polger and Shapiro present. Contrary to Polger and Shapiro's view, Christopher Viger (2000) argues for a positive ontological status of abstrata based on his interpretation of Daniel Dennett's (1987) intentional stance. Viger notes that Dennett is a materialist, an anti-reductionist, and a realist regarding mental kinds,

> Behavioral dispositions that explain intentional regularities just are beliefs and desires. The underlying mechanisms that realize behavioral dispositions are physical mechanisms (at least neurological), and for this reason Dennett is a materialist. But Dennett resists the identification, even the token identification, of a behavioral disposition with an underlying mechanism realizing that disposition. Beliefs and desires qua behavioral dispositions are real, but they are not the underlying mechanisms realizing those dispositions. (Viger 2000, 136)

To balance these positions Viger interprets Dennett as defending an ontological thesis that accepts abstracta as being real, without requiring of them that they are identified with something physical (*Ibid*, 137). Viger points out that treating mental kinds as abstracta is a description of the role they play in our *explanatory* practices. Beliefs and desires are abstracta because they are posited under certain idealizing assumptions (rationality) for Dennett; the reason beliefs and desires are abstracta is not ontological. As such, it is a mistake to take the role they play in our explanatory practices as a guide to their ontological status.

Our explanatory practices involve positing theoretical entities of varying degrees of abstractness. Abstracta should be granted real ontological status if, once posited, they play important roles in successful explanations of phenomena. Success of our explanatory practices commits us to certain ontological conclusions,

> The success of physical explanation ontologically commits us to the theoretical entities. *In the same way, and for the very same metatheoretic reasons*, we are ontologically committed to propositional attitudes. . . . The abstractness of the entities we posit depends on the idealizations we make in positing them, but their being abstract is not relevant to our ontological commitment to them, which depends entirely on the success of

> the explanatory practice from which we posit their existence. (Viger 2000, 138)

Accepting that abstracta have real ontological status provides a more secure way to assert the reality of mental kinds than Settling, as Polger and Shapiro do.[78]

To bolster the position that mental kinds qua abstracta are real, I draw a connection between Viger's interpretation of Dennett and Muhammad Ali Khalidi's account of natural kinds. Rather than accepting a view with anti-realist implications, I think adopting an account of natural kinds such as the one advanced by Khalidi (2013), is preferable. On Khalidi's account, "Natural kinds of entities are nodes in causal networks." (Khalidi 2013, 200) His view of natural kinds as simple causal kinds that factor into real causal patterns grants a positive ontological status to natural kinds that are superordinate categories. Much as Dennett defends the reality of abstracta on the basis of their legitimate role in our explanatory practices, Khalidi endorses the view that a kind is a natural kind if it participates in causal regularities that can be used in predictions about the world.

I raise Khalidi's account as an example of a realist account of natural kinds that grants ontological legitimacy to superordinate kinds. I will not go into further details regarding Khalidi's account, nor will I defend it here. I will, however, note that Khalidi's account of natural kinds as simple causal kinds, individuated on the basis of the stable causal patterns, fits well with Shoemaker's account of realization, which I defended in the second chapter. The fit between Shoemaker's account of realization and Khalidi's account of natural kinds provides some support for the notion that natural kinds can be multiply realized. This undermines the general concern Polger and Shapiro raise against multiple realization as being merely an artifact of mistakenly including abstract or ideal kinds in our ontology. Mental kinds that are, at least sometimes, multiply realized, play important roles in the prediction and explanation of human behaviours, and so, despite being abstractions (in terms of the role they play in our explanatory practices) they are

[78] Polger and Shapiro endorse four desiderata for accounts of the mental, one of which is that any account of the mental should have the result that mental kinds are real (Polger and Shapiro 2016, 15). For a more detailed discussion of the desiderata relevant to an account of the mind see the first chapter of my dissertation.

nonetheless ontologically real, in light of the success of those explanatory practices.

Returning to the specific example in this section, language lateralization, I argued that language should be treated as a broad or superordinate psychological kind that is multiply realized by different patterns of lateralization in different individuals. Contrary to this interpretation, I offered the counter argument by Polger and Shapiro that general psychological kinds, such as 'language', should be thought of as playing a worthwhile epistemic role, but not as existing in their own right. The attitude Polger and Shapiro take toward abstracta, the view they call Settle, requires that they weaken their commitment to the reality of mental and psychological kinds. Rather than accept Polger and Shapiro's account of abstract kinds, I offered an alternative based on Viger's interpretation of Dennett's intentional stance and Khalidi's account of natural kinds. On the account I defend, mental and psychological kinds are multiply realizable, are broad, general, or superordinate kinds, but are nevertheless ontologically real. Contrary to Polger and Shpairo's willingness to Settle, I argue that Postulating ontologically significant, multiply realizable, kinds is the correct stance for a realist about mental kinds, such as language, to adopt.

4. 3. Reading

The second case I discuss is reading. There are two aspects of reading as a psychological kind that I raise in this section. First, I discuss a prominent account of reading, the dual pathway account, and argue that while it may appear on its surface to be a potential example of multiple realization, it is not necessarily one. Second, I consider how learners with reading deficits can learn to read using different teaching programs. I use this example to bring up how the etiologies of a mental kind can be relevant in individuating those kinds. I argue that the way a cognitive ability is acquired can sometimes be relevant to the way that it is individuated. I consider ways that Polger and Shapiro might address the possibility that two (or more) different etiologically individuated kinds could realize the same mental kind. I present reading acquisition as a potential case where different etiologies for the same cognitive ability could result in an example of multiple realization. I conclude that there is insufficient evidence at present to determine whether individuals

who learn to read through different programs have relevantly different realizers of the same psychological skill.

Reading, as a cognitive activity, is a potential candidate example of multiple realization because common accounts of reading often present reading as being the product of two independently operating paths. Figdor (2010) mentions reading as a potential case of multiple realization in her reply to Bechtel and Mundale (1999). Broadly speaking the two paths for reading involve a visual word to phonetic path, and a visual word to semantic meaning path (Coltheart et al. 2001; Seidenberg and McClelland 1989). The paths operate in parallel and involve top-down and bottom-up feedback (see e.g., Betjemann and Keenan 2008; Price and Devlin 2011; Rastle and Coltheart 1999).[79] When a written word is perceived, for example 'bill', the phonetic path connects the visual information (the appearance of the letters on the page) to the relevant auditory features, [bɪl]. This phonetic pathway will activate other phonetically similar words as well, such as 'pill' [pɪl], or 'bid' [bɪd] (Ferrand and Grainger 1992). At the same time, seeing 'bill' will result in activity along the semantic pathway, priming semantically related concepts, such as DUCK or PAYMENT (Hutchinson et al. 2013; Meyer 2014; Meyer and Schvaneveldt 1971). Models of reading suppose that these pathways are both active while reading and that our comprehension while reading relies, in varying degrees, on one or the other pathway.

These two distinct pathways, and the different effects in which activity along each path can result, might count as a case of multiple realization. Taken at the broadest level of description, there are two ways words are read, one that decodes the visual information on the page by its association to acoustic information, and the other that relies on associations between visual and semantic information. But, there is reason to be sceptical that reading via the phonetic path and reading via the semantic path share enough in common to be considered multiple realizations of a single phenomenon (mental kind). There is a strong parallel to a point Bechtel and Mundale make regarding the two visual

[79] There is general agreement that reading involves both semantic and phonetic processing, however there remains debate regarding the penetrability of each pathway and the interactions between their activities. Debates regarding the correct characterization of the computational level, not to mention the correct algorithmic and implementation details, are on-going. The details of these different models will not be relevant here.

systems hypothesis. As Bechtel and Mundale (1999) point out through their discussion of the example of the two visual systems hypothesis (Goodale and Milner 1992; Ungerleider and Mishkin 1982) the two pathways are distinct enough in their contributions to behaviour that the possibility of multiple realization does not enter into the picture. The division between the dorsal pathway (the 'where' pathway) and the ventral pathway (the 'what' pathway) is both anatomically and behaviourally well established, and the functions attributed to each path are distinct. The degree to which the pathways are independent of each other has been the subjection of debate, but Goodale and Milner (2010) argue convincingly that interactions between the two pathways does not undermine the functional distinction drawn between ventral and dorsal processing; interaction between two paths does not imply that functions are duplicated. This point applies to the two pathways in models of reading. Reading via the phonological pathway does not duplicate the function of reading by way of the semantic pathway, and reading taken broadly is a matter of activation of both pathways simultaneously with connections between the two paths.

This illustrates the strategy of the grain argument; by making distinctions between functions clear, potential cases of multiple realization are revealed to either be descriptions of distinct functions, or that two realizers thought to be distinct ought to be counted as a single kind of realizer. In this case, the reason for why reading along two pathways does not count as an example of multiple realization is an example of Polger and Shapiro's strategy of kind splitting. As I mentioned while describing the phonetic and semantic pathways, each pathway uses different information to decode the visually perceived symbols and activation of one pathway produces different effects than activation along the other. So, insofar as reading as realized by activation along one pathway is dissociable from reading as it is realized by activation along the other path, the two potential realizers of reading are, as Polger and Shapiro say, differently different. I am in agreement that the two pathways for reading are not an example of multiple realization, however, this is not the whole story. By looking into research in the development of reading abilities (reading acquisition), and related research on reading deficits, a case for multiple realization can be made anew.

Reading is a noteworthy and peculiar cognitive ability, since, unlike vision or auditory aspects of language, there is no evolutionary history for reading as a cognitive ability. Reading as a general skill in the population is a very recent development. The acquisition of reading skills requires learners to develop new connections between visual and auditory information. The contribution of one or the other pathway to reading will change as reading proficiency is acquired (Turkeltaub et al. 2003; Schlaggar and McCandliss 2007). When one begins to learn to read it is an effortful and labourious process, but the ability becomes rapid and automatic as a reader becomes fluent. The study of reading deficits shows that poor phonological awareness is associated with reading difficulties (Bradley and Bryant 1983; Wagner and Torgesen 1987; Wagner, Togesen, and Rahotte 1994). Phonological awareness describes the extent to which an individual is aware of, and able to manipulate, sounds that compose words in their language. However, a deficit in phonological awareness is not the only potential cause of reading deficits, there may be deficits in the way that reading becomes rapid and automatic (Norton and Wolf 2012). Different types of instruction or training can be used to assist individuals who have a reading deficit and different types of instruction may be more or less helpful depending on the kind of reading deficit an individual is experiencing. To make the case that reading is multiply realized I want to focus on differences that might occur between individuals with respect to the entirety of their reading networks.

In considering how readers might compensate for a particular deficit there are two possible ways reading could be multiply realized. First, it is possible that different readers rely more on one or the other of the two pathways, or that depending on the task activation along the two different pathways could vary. Whether reading, when it is realized by different degrees of activation along each pathway in different individuals (or by the same individual at different times), counts as a single cognitive or psychological kind (ability or process) is an open question. It is an open question in the sense that whether reading should be split into many different cognitive of psychological kinds (e.g., reading primarily via the phonetic pathway, reading primarily via the semantic pathways, reading using both pathways in a balanced manner, etc...) or viewed as single kind, with

some tolerance for a degree of individual variation in reading skills, is not determined before hand, merely on the basis of theoretical descriptions of the processing along the pathways. Empirical evidence about the way that readers resemble or differ from each other and how those differences and similarities relate to what we know about the brain networks that are associated with the semantic and phonological pathways must be considered before a decision regarding the multiple realizability of reading can be reached. It suffices to raise the possibility that reading is multiply realized that activation along the pathways comes in different degrees, and there may be large enough differences in some cases that we would not want to count all the variations as belonging to the same kind.

Second, there are times when the etiology of a mechanism is relevant to its identity and individuation. Even if the dual pathways for reading are supported by the same brain areas and mechanisms, the way that an individual acquires and develops those pathways might matter to how the realizing mechanisms are individuated. Suppose that there is a single mechanism that realizes our ability to read, built from two pathways, so that there is only one realizer (the network in the brain that consists in both pathways acting together) of reading. In other words, suppose that the defender of multiple realization was to concede that there is a single unique realizer of the cognitive/psychology kind, reading. Nevertheless, if the mechanism has different etiologies in different individuals, there might still be circumstances where two (or more) reading networks are distinguished as being realized by different mechanisms, because the mechanisms in the two cases have distinct etiologies. To illustrate how different etiologies can lead to the same outcome, but that at the same time there remains a reason to distinguish the etiological kinds I outline a study by Lovett et al. (2000) which looked at different remediation programs for children with reading deficits.

Lovett et al. (2000), looked at the effects and efficacy of different methods of reading instruction for children (ages 6 to 13) with reading deficits. The authors compared the efficacy of two remedial approaches for reading deficits, the PHAB/DI (Phonological Analysis and Blending/Direct Instruction) and WIST (Word Identification Strategy Training). Both training programs aim to increase awareness of phonological features of

language and the relationship of sounds to symbols. PHAB/DI training focuses more on instruction aimed at increasing the awareness of relationships between minimal units of phonological information with the related visual cues (i.e., letters), whereas WIST focuses on training readers to use four general metacognitive strategies (Lovett et al. 2000, 265a). The study divided the eighty-five participants into five groups that each followed a different program. One group spent seventy hours studying the PHAB/DI program (PHAB/DI X 2), a second group spent their seventy hours learning the WIST program (WIST X 2), the third group spent their first thirty-five hours of instruction learning the PHAB/DI program and the other thirty-five hours learning the WIST strategies (PHAB/DI→WIST), the fourth group began with the WIST program for thirty-five hours of instruction followed by thirty-five hours of instruction in the PHAB/DI program (WIST→PHAB/DI), and finally the fifth group was a control group that received instruction on mathematics, and general classroom and studying skills. A variety of different tests to measure different aspects of reading were used to assess the effects of the different programs. Measurements were used to assess both awareness of phonological features in isolation, by testing sound to grapheme knowledge and reading of non-words, and general reading ability, by testing reading of regular and irregular words and passage comprehension.[80] The effects of the different programs were compared against gains made by the control group and against each other.

To start, all four targeted programs outperformed the control, but the results I want to draw attention to for the purposes of this example are that individuals who were instructed using the combined programs, PHAB/DI→WIST and WIST→PHAB/DI, outperformed those who were taught using a single program, PHAB/DI or WIST (See the

[80] In the study there were five different experimental groups that were tested using four major testing categories, each of which was itself subdivided into additional testing categories. Each of the groups was compared to the others on each of these measures, so that there are many contrasts between the different programs. Additionally, the study collected test performance measurements at five separate points (pretest, mid-session 1, post-session 1, mid-session 2, post-session 2). Given the breadth and depth of the data collected I will limit my discussion to the major trends that were observed across the different testing categories. I draw attention to the number of different measurements here to acknowledge that if one wanted to focus on a different grain of description to describe the various different aspect of reading performance, one could. However, since this study did not look at neural correlates at all, there is no reason to try to match grains of description between psychological and neural kinds.

graphs in Lovett et al. 2000, 276-278 for a quick summary of the contrasts between the different programs). On most of the measurements there was little difference between the two combined programs, with one exception:

> Although on the majority of outcome measures, the sequence in which participants received the PHAB/DI and WIST training was not of primary importance, on this measure of nonword spelling knowledge, sequence did matter. (*Ibid*, 278)

The exception that was observed, better spelling of nonwords that follow implicit spelling patterns of English words, showed an advantage for the PHAB/DI→WIST sequence over the WIST→PHAB/DI sequence. The authors hypothesize that this effect is due to the way that PHAB/DI focuses on smaller units of phonology, whereas WIST focuses participants awareness on larger syllabic units (*Ibid*, 278). Setting aside this difference, the two combined programs resulted in comparable gains across the different measures of reading competency. But, the learning curves to get to the similar end points are fairly different. This suggests that there are multiple ways of learning the same skill.

To add plausibility to the notion that the differently ordered programs of instruction can be thought of as producing multiple realizers of the same skill, I propose some hypothetical details to add to the Lovett et al. study. To begin, suppose that the WIST program of study has a greater impact on processing by the semantic pathway and the PHAB/DI has a greater impact on the phonetic pathway. This is plausible to suppose given what the two programs aim to target in terms of reading skills. Next, suppose that there are relevant neural changes in both those pathways as a result of the different experiences. The semantic pathway and the phonetic pathway change to reflect the learning and experience that causes activation in the pathways. Since PHAB/DI and WIST affect the pathways differently, the order in which WIST and PHAB/DI are taught (whether an individual participated in the PHAB/DI→WIST or the WIST→PHAB/DI instruction) changes the order in which the reading network is altered. The order of the changes has the potential to be reflected in the way that the network is organized, so that the reading networks of PHAB/DI→WIST are a different etiological kind from the reading networks of individuals who participated in the PHAB/DI→WIST program.
As Polger and Shapiro themselves point out, in biological systems the order of changes to

a system can have subtle but lasting and significant impacts on the way that system behaves in certain situations.[81] (Polger and Shapiro 2016, 140-143) Taking these considerations together suggests that while the reading skills that result from both the combined intervention programs (PHAB/DI→WIST, and WIST→PHAB/DI) are comparable, there are times when it is appropriate to individuate the reading networks based on their etiologies. There are contexts in which the etiology is important, in this case we can look to educational applications to understand how different individuals use different types of instruction to acquire the same skill.[82]

As with the language lateralization example, I apply Shoemaker's account of realization to describe the example of reading acquisition. The mental property in this example is the ability to read. So, the forward-looking causal power is simply the ability to associate visual symbols (written words) with meanings of those particular kinds of symbols. What is distinct about this example are the backward-looking causal powers related to the acquisition of the ability to read. The proximate backward-looking causal properties for reading are a working visual system that can perceive the written words, familiarity and willingness to perform the relevant task, and the knowledge or memory of how to decode written symbols to associate the correct meaning to the perceived script. The question that the example of reading acquisition raises is, should backward-looking causal powers of a property that are from its distant past be included as individuative of that property? Obviously not every backward-looking causal power is relevant to the core realizer, since even though properties such as 'being born' or 'Earth's having an oxygen rich atmosphere' are required for particular instantiations of so-and-so's reading of some printed word, they are not individuative of the property of being able to read a particular written word at a particular time. Learning to read is a more proximate backward-looking cause of any particular act of reading than the peripheral causes of the total realizer just

[81] "Importantly, circumstantial and nomological constraints often accumulate as a result of each other's presence. . . . What we see, then, is an interplay between circumstantial and nomological constraints where one leads to another, which in turn leads to the other, and so on." (Polger and Shapiro 2016, 142; see also Shapiro 2004, 80-84, 87-93)

[82] Etiology matters for many research programs in biology. Understanding the development of an organism over its lifetime, and the lineage of the organism across evolutionary time, both appeal to etiology. Counting properties or traits of an organism as belonging to the same or different kinds, depends on the context in which they are being compared. See for example, Currie (2014; 2013) and Ereshefsky (2012; 2009; 2007).

listed. The core realizer of an instance of reading is activation in the properly tuned reading network of an individual.[83] For an individual to have a reading network that is capable of responding appropriately to the incoming stimuli of perceived written words, they must have acquired the necessary connections between the auditory, visual, and semantic features associated with those words. So, does acquiring a core realizer in different ways count as enough of a difference to distinguish one kind of realizer from another? That is, do individuals who learned to read through participation in the PHAB/DI→WIST or the WIST→PHAB/DI training programs differ in the realization of the reading ability that they acquire?

The example raises the question of whether differences among the etiologies of two kinds that otherwise share their relevant features count as different realizers of a kind. The question is, when there are two kinds that differ in their etiologies but resemble each other (or are even identical with each other) in other relevant respects, is this a case of multiple realization? Neither an affirmative or negative answer seems to be obvious. Polger and Shapiro deny that such a case could count as multiple realization, because multiple ways to cause the same effect is not evidence for multiple realization,

> Multiple realization, we noted, amounts to more than just multiple causes for some effect. . . . After all, we always knew that there was more than one way to produce an effect. (Polger and Shapiro 2016, 46)

In support of this line of reasoning it should be noted that realization is a synchronic relationship, whereas etiological considerations are essentially diachronic. Because realization is not sequential, a property and its realizer are present simultaneously, the causal history leading up to a particular moment when a property is realized is, presumably, not relevant. On P&S's view, differences prior to the realization of a property won't affect the way that the synchronic relationship of realization should be assessed. This means that it seems strange to talk about etiological kinds as being realized or being realizers. But this is a mistaken way of thinking about etiological kinds as being realizers. An etiological kind is individuated based on its causal history, but that doesn't mean that a

[83] By 'reading network' I do not mean to invoke a computational account of mental or psychological kinds, I simply mean that there must be several different brain areas that are interconnected and each of those areas will be active while an individual performs a reading related task.

kind identified on this basis cannot participate as a relatum in the realization relation any differently from a kind identified in another manner. Excluding etiological kinds as potential cases of multiple realization based on the manner by which etiological kinds are individuated is not justifiable.

To illustrate why, recall (see chapter 3, §3.3.) the four requirements Polger and Shapiro advance for a case of multiple realization:

> 1. As and Bs are of the same kind in model or taxonomic system S1.
> 2. As and Bs are of different kinds in model or taxonomic system S2.
> 3. The factors that lead the As and Bs to be differently classified by S2 must be among those that lead them to be commonly classified by S1.
> 4. The relevant S2-variations between As and Bs must be distinct from the S1 intra-kind variation between As and Bs. (Polger and Shapiro 2016, 67)

The first two requirements are that the entities under consideration belong to the same kind in one taxonomic system, but to different kinds according to another taxonomic system. Kinds that are classified together according to their etiology are not necessarily classified together according to other taxonomic systems, so some etiological kinds potentially meet the first two requirements. But, it seems unlikely that the kind of variation that is taken into account when classifying kinds based on their etiology will not count as being intra-kind variations in another taxonomic system. So the third condition rules out etiological kinds from possibly generating cases of multiple realization. The manner by which etiological kinds are grouped together or individuated will be independent from any considerations in different taxonomic systems for grouping or dividing kinds within those systems. So, etiological kinds should not even raise the possibility of multiple realization on Polger and Shapiro's account. However, I make the case that Polger and Shapiro do not exclude all etiological kinds from consideration. Once the door is open for considering etiological kinds, I argue that cognitive abilities acquired via different educational experiences can at least be considered as potential examples of multiple realization.

I contrast Polger and Shapiro's position with a discussion of etiological kinds by Muhammad Ali Khalidi (2013). Khalidi's interest lies in showing that etiological kinds count as natural kinds, according to his account of natural kinds. Khalidi correctly points

out that in biology there are cross-cutting taxonomies for the traits of an organism. The clearest case of the way that the taxonomies crosscut each other can be seen in the comparison of the definitions of 'homologue' and 'analogue'. Traits are homologies if they are “classified together in different species of organisms despite their differences in synchronic causal properties, because of the fact that they share a common ancestry.” (Khalidi 2013, 131) Homologies are not cases of multiple realization. But the converse kind of case, known in biology as *analogies*, are perfect candidates for multiple realization. Traits of an organism that share causal powers but have different evolutionary histories are *analogous*. Khalidi recognizes that multiply realizable kinds are often excluded from counting as natural kinds. Despite their compatibility with multiple realization, Khalidi argues that etiological kinds are legitimate natural kinds on the grounds that they play stable roles in causal patterns that can be studied scientifically,

> A complete causal account of the universe should preserve differences in causal outcomes as well as differences in the causal processes that led to those outcomes. Some of the examples mentioned of etiological kinds demonstrate that science is concerned not just with understanding the synchronic causal powers of individuals or entities but also with the causal processes that led to them being the way they are even when their current causal powers are identical. If real causal patterns are what we are interested in tracking, there is no reason to focus exclusively on the synchronic ones as opposed to the diachronic ones. (*Ibid*, 135)

And, as Khalidi points out, etiological kinds are not restricted to biology; such kinds also appear in geology and cosmology (*Ibid*, 134). The general point being that etiological kinds play a role in diverse scientific practices. They describe causal facts about the world, and they do so in a useful manner. On these grounds Khalidi reasons that they cannot be barred from counting as legitimate natural kinds. Since etiological kinds are legitimate scientific kinds, some etiological kinds meet the first two conditions of Polger and Shapiro's conditions for multiple realization.

Polger and Shapiro recognize that analogies in biology are good candidates for examples of multiple realization, and they deal directly with some of those cases. To counter those cases they make use of strategies they call Convergence and Homologies (Polger and Shapiro 2016, 179-80). Their strategies for dealing with examples of multiple

realization drawn from biology ask us to look closer at the way that evolutionary constraints operate. They argue that analogies fail to count as examples of multiple realization because, when tracked carefully, analogues share important structural properties, and those structural properties can be explained by appeal to a shared common ancestor in their evolutionary history. But, as I noted at the beginning of this section, the example of reading doesn't involve evolutionary considerations. What is noteworthy is that, in dealing specifically with examples from evolutionary biology, Polger and Shapiro implicitly acknowledge that etiological kinds can sometimes generate putative cases of multiple realization. And the manner that they deal with those examples does not suggest that etiological kinds cannot generate cases of multiple realization, just that examples from evolutionary biology will often fail to count as cases of multiple realization due to the complexity of biological systems and the way that complexity in biological systems produces constraints that lead to a single kind of realizer for any biological property.

Nothing Polger and Shapiro say in their discussion of Convergence and Homologies suggests that etiological kinds are in principle off the table. The example of etiological kinds I raise based on studies dealing with reading networks and reading deficits have nothing to do with evolutionary history, so the arguments regarding evolutionary constraints will not directly speak against the examples. However, I do not think that the example of different instruction programs that can result in the same reading skills is a clear-cut example of multiple realization.

On the one hand, I think there is good reason to take a close look at the example, and to think carefully on whether different orders of instruction that result in the same abilities (though perhaps not in identically tuned reading networks) could count as multiple realization. The different order that instruction programs, PHAB/DI→WIST and WIST→PHAB/DI, can be taught end up with (just about) the same results in terms of gains in reading ability, but the routes taken to acquire those gains are different. The different ways that the instruction programs result in changes to the pathways will be preserved in the changes to the reading network that take place. The overarching aim of the study by Lovett et al. (2000) is to better understand what can be done to help individuals with reading deficits overcome the deficit. Knowing the etiologies of the

acquired reading skill is a relevant aspect in that endeavour, and so might count as a relevant kind as individuated within a scientific pursuit.

On the other hand, etiologies are not often taken into account when individuating a kind on a different basis. Though Khalidi argues that etiological kinds count as genuine natural kinds, he acknowledges that etiological kinds are unlike typical natural kinds.

> Having defended the position that etiological kinds can be natural kinds, it is worth stating that etiological kinds do seem to constitute a genuinely different type of natural kind than the other kinds we have been considering. The properties associated with them do not generally lead to the causal generation of a series of other properties or initiate a sequence of other properties. (Khalidi 2013, 135)

On Khalidi's account, most natural kinds are identified by their causal properties, such that those kinds produce or predict certain regularities. He relates his account to an account proposed by Craver (2009), which he calls a simple causal theory of natural kinds (Khalidi 2013, 201). According to the simple causal theory,

> [N]atural kinds are associated with a set of properties that are causally linked to other properties in a sequence or network. When the properties associated with a natural kind are instantiated or co-instantiated, they lead reliably to the instantiation of a number of other properties. Since they are implicated in repeatable patterns of properties, they enable us to explain and predict phenomena in the natural and social worlds. (*Ibid*, 201)

Etiological kinds look backward in time for the conditions that individuate them. While a particular causal history might generate enough constraints that the knowledge of a kind's etiology might permit some predictions based on that kind, there is no guarantee that this will be the case. The way that evolutionary constraints can accumulate so that eventually a single structure is the only trait likely to evolve is the way that Polger and Shapiro deny that different etiologies are likely to produce the same realizer of a particular mental property or kind. Polger and Shapiro reason that etiological kinds will rarely diverge from kinds individuated in other ways. This type of reasoning could apply to the etiological kinds I have been discussing as well. Perhaps there are enough constraints on the way that we acquire new cognitive skills and abilities that there is only a single way that the neural structures that realize the reading network can be. Or at least that the variation among individuals' reading networks are merely individual variability that doesn't result in

multiple realization.

At present we don't know enough about the developmental changes that take place in the brain while learning to read. Nor do we know whether those changes are similar in individuals with reading deficits compared to individuals who develop normally. But it does seem to me that we can ask the question of whether individuals who develop differently, even if they do end up with the same reading skills at the end, have different realizations of a given mental kind based on the different etiologies of that mental kind in different individuals. So, I concede that the case study of different kinds of remediation for reading deficits does not count as clear evidence in favour of multiple realization. It remains an open question.

This is exactly as it should be if multiple realization is to be decided on empirical grounds. It may yet be discovered that reading is multiply realized. If it turns out that the acquisition of reading via different etiologies (i.e., different teaching methods) is important to how groups of learners are taught, such that though the learners begin with differences in their reading networks (or what will become their reading networks) different teaching interventions with the different groups results in those groups all achieving the same skill in reading (and the same neural realization of reading by their reading networks), then there is an important distinction to be made on the basis of the etiologies. Readers would eventually be differently the same, as Polger and Shapiro require. However, it may also turn out that the different starting points and different etiologies result in differences in the reading networks of individuals, in which case they would be differently different, and so not count as an example of multiple realization. Given the challenges in collecting developmental changes to the reading network over the long period of time where reading is acquired, the empirical evidence to decide this question could be a long time coming. In the next section I present another example of a mental kind related to language where the etiology of that kind can make a difference; second language learning. The upshot of discussing this example is that more is known about language localization in the brains of multilinguals.

4. 4. Bilingualism and multilingualism

The final example I discuss is second or multi- language learning. There is a considerable difference between the acquisition of a first language and that of subsequent languages (not to mention cases where several languages are acquired from birth simultaneously). As in the case of learning to read, there are many different ways that a second (or third, and so on) language can be acquired. And, as in the case of reading, learning a new language begins as a difficult and slow process, but over time one may become fluent in the new language. Learning a second language can also change how one's native language is processed (Whitford and Titone 2015; Jasińska and Petitto 2014; Mechelli et al. 2004; Abutalebi, Cappa, and Perani 2001). There are two arguments I present in favour of multiple realization on the basis of second language learning. First, I raise the fact that cognitive abilities are sometimes located along a continuum. I present Polger and Shapiro's (2016) argument that the kind of variability this kind of continuum is evidence for does not provide unambiguous support for multiple realization. However, I argue that the neural differences observed between monolinguals and bilinguals does provide evidence for multiple realization. The second case I discuss focuses on the differences between languages. Focusing on differences between spoken English and Mandarin, I highlight how different languages can also involve different neuroanatomical functional localizations. These localizations are not the same for second-language speakers of the relevant language.[84] I argue that these differences are best understood as evidence for multiple realization.

Acquisition of a second language presents a good example of an ability that comes in varying degrees. With regard to learning a second language, there are many factors that can influence how quickly or successfully a second language is acquired. Two key factors are the age of acquisition of the second language, and the amount of exposure to the second language the learner receives (Hernandez and Li 2007; Perani et al. 2003; Perani et al. 1998). The order that the additional language(s) are learned, particularly if the learner is acquiring a third (or more) language, is also be relevant (Onishi 2016; Kemp

[84] When discussing bilinguals, it is common to refer to the first language an individual learns as their L1, and the second language as their L2.

2007; Cenoz 2003; Sanz 2000).[85] These factors point to the importance of the etiology of a particular language ability. As in the case of reading acquisition, there may be cases where the etiologically individuated kinds differ from the neuroanatomical or functionally individuated kinds, presenting one avenue for the multiple realization of language. A second way that I argue for multiple realization is that that given the observed differences between monolingual and bilingual speakers, there is evidence that the language abilities related to the first language are multiply realized when monolinguals are contrasted with bilinguals.

To make a case for the multiple realization of a second language, consider the following hypothetical scenario. A key point to keep in mind for this example is that the proficiency in understanding spoken German (the psychological ability or relevant mental kind) is shared by the two characters, A and B. So, suppose there are two students who are trying to learn German as a second language; A began to learn German at seven years old and spends five hours each week receiving German language instruction for three years (for a total of 780 hours of instruction), but does not speak or hear German outside of the classroom, and B who is eighteen years old and receives six hours of German instruction daily (five days a week) for six months (for a total of 780 hours of instruction) and is living in a community where German is the primary language. A and B have different ages of acquisition, years of exposure to German, and contexts in which they learned and use German. The example is constructed such that they have received the same number of total hours of instruction. Now, imagine that both A and B are tested on their understanding of German and they receive the same scores on the tests for oral comprehension. So, what is shared between A and B is their ability to comprehend spoken German. The effects of age of acquisition, duration of exposure to the language, and type of instruction and learning, in addition to the age differences (A is ten and B is 18), suggest that there are likely different factors that affect in their performances on the comprehension test. The factors that contribute to A's achieving their score on the test are their early age of acquisition and the relatively long-term exposure to German, whereas

[85] The differences between monolingualism, bilingualism, and multilingualism, and the methods to study multilingualism, are subject to ongoing debates (e.g. Lüdi and Py 2009; de Bot 2004). The complexity of the issues surrounding the study of multilingualism go far beyond the scope of this paper.

B's score on oral comprehension have to do with the immersion in a German speaking environment and the more intensive instruction, as well as B's age (and so greater experience with language generally). Those differences include neural differences that reflect the differences between A and B's experiences learning German.[86] In short, there are different reasons that A and B both share the same ability to understand spoken German as their second language. The differences, however, may not be *relevant* differences, as Polger and Shapiro's third desideratum requires.

In comparing individuals with early and late ages of acquisition there are many different confounding factors that have to be taken into account. Most obviously, an individual who begins to learn a language at an early age will have more exposure to that language over the course of their life than an individual who begins to learn the same language later in life. There are also many factors that are not directly relevant to language, such as general intelligence or the age of the individual, that also impact the performance on tests of language comprehension. The large number of different factors that influence the way in which one learns a second language presumably all have neural correlates. So, the differences among learners will be reflected in neural differences. The sheer degree of variability that is possible would appear to provide a prima facie example of widespread multiple realization. However, this conclusion is too hasty. The type of variability among these individual second language learners can be explained away in several ways. First, a reply that appeals to the grain argument is available to deny that multiple realization occurs. Talk of the fine-grained differences among all the various factors that impact second language learning, and descriptions of an individual's second language abilities, say their aural comprehension of the second language that they are learning, involve mismatched grains of description.

To bolster the intuition that there is an illegitimate mismatch between the descriptions of second language abilities and the many factors that influence second language acquisition, apply the consideration that Polger and Shapiro make regarding

[86] It might appear that I have begged the question by asserting that there are neural differences between A and B, however this stipulation is in line with empirical evidence regarding differences between learners with early AoA (age of acquisition) and learners with a late AoA (Wei et al. 2015; Hernandez and Li 2007; Perani et al. 2003). Given the empirical evidence that differences in age of acquisition are reflected in neural differences, my description in this example should not be viewed as problematic.

Individual Differences. Recall that Polger and Shapiro reasonably argue that not all differences are relevant differences, and that many scientists tolerate individual differences as within-kind variation, not evidence for multiple kinds. Multiple realization, on the conditions advanced by Polger and Shapiro, requires there to be two distinct kinds, as they are individuated in one taxonomic system, that act as realizers of a single kind, as it is individuated by another taxonomic system. Individual differences among members of a kind are not grounds for splitting that kind into multiple kinds in another taxonomic system. Descriptions of individual differences are too fine-grained to justify splitting a kind. P&S could argue that the number of different factors relevant to second language learning should be viewed as the kind of tolerable individual variability, and are thus not evidence for multiple realization on their own.

While these small differences don't amount to a difference in kind, there is one difference between monolinguals and bilinguals that does. When a monolingual is hearing or speaking the language that they know, they are simply performing a language related activity in the only way that they can, whereas a bilingual (or multilingual) individual has an extra step they must successfully perform; they must identify which of their languages is being used presently. A multilingual must correctly activate the knowledge about the relevant language and suppress knowledge from other languages when speaking, reading, or listening to one of the several languages they know.[87] As I noted in the previous section with respect to learning to read, much of the processing of language is automatic, rather than conscious or effortful, and implicitly performed, rather than under explicit control. Presumably the challenges faced by production (speech) and comprehension are different, and intuitively production tasks will be more difficult. For both production and comprehension the engagement of the correct language's lexicon and phonology is not consciously controlled, nor is the inhibition of their other language something a bilingual must actively do. Nevertheless, the difference between having one choice or two, consists

[87] The inhibition of alternative words (phonological or visual word forms) is not a challenge uniquely faced by bilinguals. Even monolinguals must often select a single word from among several synonyms, for example an English speaker may have to choose between 'seat' or 'chair', or between 'couch' and 'sofa', when talking about pieces of furniture. Nevertheless, the challenge faced by the bilingual compared to the monolingual is broader in scope than the challenge faced by monolinguals who must choose between synonyms.

in a more than quantitative change when it comes to speaking and understanding one or multiple languages.

To study how multilinguals switch between languages that they know distinct tasks, that require participants to alternatingly use one or the other language, must be used. For example, a participant might be asked to perform a picture naming task where they are also cued to name the picture in one or another language, or they may be given the choice of which language they use to name the presented picture (e.g. Blanco-Elorrieta and Pylkkäne 2017; Kleinman and Gollan 2016). Interestingly, there is little (if any) cost to this extra cognitive activity (Nichols et al. submitted; Ma et al 2014; Spalek et al 2014; Starreveld et al 2013; Hernandez et al 2001, cf. Rodriguez-Fornells et al 2005).[88] Research into the manner by which the bilingual brain distinguishes between languages has not localized this ability to a distinct area of the brain. Rather, it appears that areas in the brain network use different patterns of neural activity to distinguish multiple languages (van Heuven and Dijkstra 2010; Nichols et al. submitted).

What is evident is that the processing of a particular language by a bilingual involves many of the same neural networks for either language. In particular, the semantic features of language abilities should show considerable overlap, since the meanings of words from different languages will be more similar than the auditory or grammatical features of those languages. Take, for example, neuroimaging studies that compare English and Mandarin (e.g., Ma et al., 2014, Malins and Joanisse 2010, 2012; Tham et al. 2005; Klein 1999). Unlike English, Mandarin is a tonal language; the pitch with which a phoneme or set of phonemes is pronounced in Mandarin carries different semantic information, which is to say that a word, for example /ma/ pronounced with a rising tone (sometimes represented as /má/) and which means 'hemp', has a different meaning than /ma/ pronounced with a falling tone (sometimes represented as /mà/), which means

[88] There is a cognitive cost, evidenced by slowed reaction times of responses, associated with repeated switching between one language and another in some laboratory contexts (Blanco-Elorrieta 2017; Hartanto and Yang 2016; Kleinmn and Gollan 2016). There is also evidence of the importance of the more domain general cognitive process of executive control in language switching tasks. My focus here is not on cases where an individual must switch between languages (repeatedly) in a single context, but on cases where a bilingual individual is simply using one or the other of their languages for an extended duration. The study of task switching and language switching are distinct areas of interest and are outside the focus argument I present.

'scold'.[89] Given this difference in auditory information understanding English or Mandarin requires the processing of different auditory cues. Learning Mandarin as a second language requires English speakers to learn to attend to tone in a manner not required to understand English. The structure of written Chinese also provides a contrast with English. Chinese characters are logographic, and bear relatively sparse phonological information (i.e., Chinese characters provide relatively few cues to indicate how they are to be pronounced), whereas the English alphabet used to represent words carries a large amount of phonological information (but this is not to suggest that written words in English are phonologically transparent). So English and Chinese differ both in auditory features that are important to their comprehension and in the phonological information contained in their written forms. Given these differences the question has been asked whether speakers of the two languages use different neural resources as parts of their language networks. For example, are the same neural areas active when an L2 Chinese user hears or reads Mandarin as when an L1 user of Chinese does?

This question points to one of two possible ways that bilingualism could serve as an example of multiple realization. If speakers of a second language process their L2 differently from native speakers of that language, but are capable of reaching the same level of proficiency as native speakers, then this would count as evidence for multiple realization. A second way that bilingualism might provide support for multiple realization is if the processing (and related neural resources) of the first language changes depending on whether one is bilingual or monolingual. With regard to the first possibility, I concede that it may be impossible to learn to speak a language in exactly the same manner as a native speaker because second language speakers are very likely to speak their second language with an accent, but the degree to which we attribute fluency to a speaker will depend on the kinds of measurements or tests used to assess a learner's fluency. Much of the research into the manner by which individuals achieve fluency in their second language focuses on a contrast between early and late ages of acquisition for highly proficient second language users. There are notable differences between second language

[89] Mandarin Chinese has four tones: high level, mid-rising, low dipping, and falling. Pronounced with each of these different tones respectively, /ma/ can mean 'mother', 'hemp', 'horse', or 'scold'.

users with early age of acquisition (AoA) compared to late AoA speakers (Nichols and Joanisse 2016; Cao et al. 2013; Peng and Weng 2011; Hernandez and Li 2007; Perani 2003).[90] So, one potentially important way that a second language could be multiply realized is through differences between early and late ages of acquisition. That there are differences in localization of the language networks of early versus late age of acquisition language users who are matched for proficiency is one way that the same language abilities are multiply realized. Although this is not quite the same as showing that L2 users have a different realization of a language from L1 users of that same language, it indirectly supports the notion that the same language can be differently realized in different individuals.

To strengthen the view that these realizers are sufficiently distinct from one-another, I apply Shoemaker's account to describe what the realizers of the relevant property are. Shoemaker's account makes clear what the realizers of the mental kind are. Once the realizers are identified the mater of counting the number of distinct realizers can be addressed.[91] Focusing just on speech comprehension, there are three groups of individuals to be characterized: bilingual L1 speakers of a language, early AoA bilingual L2 speakers of that language, and late AoA L2 speakers of that same language. Activation in the language related brain areas of early AoA L2 speakers more closely resembles the activation observed in L1 speakers of that language than activation in late AoA L2 speaker's does. Looking at the difference between late and early AoA L2 speakers, there are differences between the two groups in where language related activation is localized, such that for later AoA there is considerably greater activation in their right-hemisphere in language related areas than when those speakers are using their L1 or for individuals who

[90] Distinguishing effects of proficiency from age of acquisition is challenging. Some research suggests that proficiency is the sole or main determining factor for observed differences in neural patterns of activation in bilinguals (Perani et al 1998; Chee et al 1999). The issue is even more complex, since independently from age of acquisition and proficiency there is a third factor, the frequency with which an individual uses a particular language, that also importantly affects the language network (Perani et al. 2003; Zevin and Seidenberg 2002).

[91] As indicated in the introduction, Shoemaker's account of realization is useful for individuating the mental kind that is being realized, and for identifying the physical kind(s) that are the realizer(s) of the mental kind, but on its own it does not provide guidelines for deciding whether a mental kind has multiple realizers or not. On the other hand, Polger and Shapiro advance conditions that must be satisfied by cases of multiple realization. Their conditions apply when determining whether two realizers are different in the right kind(s) of way(s) to count as an example of multiple realization.

are matched for proficiency, but who have an early AoA (Nichols and Joanisse 2016). The Nichols and Joanisse (2016) study shows that when contrasting individuals with early compared to late age of L2 acquisition there are differences within the same structures that make up language networks of speakers, as well as differences between the brain regions that are active when performing L2 related tasks. Specifically, Nichols and Joanisse used a task where participants were required to determine whether an aurally presented word matched a visually presented picture while fMRI data was collected in a scanner. Behavioural data was collected using two tests, the Hanyu Shuiping Kaoshi and the Test of English as a Second Language that assess grammar, reading comprehension, and vocabulary (Nichols and Joanisse 2016, p. 16).

Using Shoemaker's account to analyze this example, keeping a narrow focus on the specific task performed in the scanner and the differences in activation between early and late AoA bilinguals, a case can be made that there are multiple realizers of the same mental property. The property in question is the ability to match the names of visually presented pictures to aurally perceived words. The backward-looking causal powers include visual and auditory perception of the relevant stimuli and the stored knowledge to compare the names of pictured items to the names played over the speakers. The forward-looking causal powers are the ability to compare the meaning assigned to the picture with the word that is heard and making a decision that is reported via a button press. Down the line other forward-looking causal powers will be the possibility that the individual can recall and report on the pictures they saw or the words they heard while performing the task. As always, the realization of this property involves an individual's perceptual apparatus, past experience and learning that is stored through changes in that individual's brain, and activation in relevant brain areas. Moreover, the individual must have the ability to translate their knowledge and decision regarding the language decision task into a motor response. But again, most of these requirements have to do with the total realizer, rather than the core realizer. Of course, you need to be able to see, hear, and move your fingers to complete the specific task, but none of those features are really individuative of that particular task.[92] The core realizer of the language related task, specifically focusing

[92] All of this serves as a reminder of the importance of task design and the prevalence of the subtraction

on the task of understanding aurally perceived words from an individual's L2, varies depending on the AoA of the individual. Comparing individuals with late vs. early AoA there are multiple brain areas that differ in the degree to which they are active during the processing of L2. For individuals with late AoA, greater activation than that observed for individuals with early AoA is found in both the left hemisphere (IFG, STG) and the right hemisphere (STG, IFG, and parahippocampal gyrus) (*Ibid*, 18). While the activation is located in shared areas that are all generally associated with language processing, there is a difference in the realizers that is not reflected in a difference in performance, so there are different realizers of the same mental kind in this case.[93]

The second reason for thinking that research into differences between bilinguals and monolinguals supports multiple realization is that there are differences in how bilinguals realize their L1 compared to monolinguals. In particular, there is considerable evidence that the language network in early bilinguals is more bilaterally distributed than in monolinguals (Ding et al. 2003; Hull and Vaid 2007, 2006, 2002; Lam and Hsiao 2013; Peng and Wang 2011; Tham et al. 2005). In the case of high proficiency early bilinguals their language network has a greater propensity to be bilaterally distributed, rather than to show the strong left hemisphere lateralization that is typical (in monolingual right-handed individuals). All of the studies regarding multilingualism I have discussed excluded left-handed individuals. This is significant, since left-handed individuals also have a greater propensity for showing bilateral distribution of their language network. I argued that the case of a bilateral distribution of the language network, as compared to the strong left hemisphere lateralization observed in most right-handed individuals, counted as an

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method. The logic of the subtraction method is that two tasks are compared and performance on one task is (hopefully) different from the other in only a few (ideally one) ways(s)s, so that the difference in responses (behavioural and physiological) the tasks elicit can be attributed to the way those tasks differ. Both the target task and the control will, presumably, evoke a response from parts of the total realizer, but the difference(s) in response between the targeted task and the control task should be of use in discovering the core realizer of the targeted task.

[93] Nichols and Joanisse do note that the general increase in activation for individuals with late AoA may be indicative of those individuals putting greater effort into processing their L2 than those individuals with earlier ages of acquisition (2016, 20). It is likely that deniers of multiple realization will insist that the increase in effort and energy put into performing a task consists in a relevant difference in the identity of the task itself, so that there are not two realizers of the same capacity, but rather there are two different tasks that are realized differently. However, reinterpreting the case in this way involves treating the identity theory as though it is unfalsifiable.

example of multiple realization. The present evidence regarding the way that early bilingualism influences the lateralization of the language network in some individuals is another way that the language network ends up being more bilaterally distributed.

Finally, in discussing bilingualism, I would like to draw attention to another area of investigation that indirectly runs counter to identity claims. Related to the question of whether an L1 and L2 speaker use the same neural resources to process their shared language is the question of how much overlap there is in the language network for the processing of different languages by a multilingual? Different degrees of overlap are hypothesized. It is commonly accepted that the meaning of lexical items will generally overlap between languages (Cao et al. 2013; Chee et al. 1999; Chee, Tan, and Thiel 1999; Isel et al. 2010; Klein et al 1999; van Heuven and Dijkstra 2010). The meanings of words, the lexicon, are shared between languages in multilinguals, but there is greater debate over whether the processing of phonological and grammar are overlapping. For example, Isel et al. (2010) argue, based on work with French-German bilinguals, that the meanings of single words can prime words in another language, but that grammatical features are not primed in this manner. Connecting the observation that some features of multi-language processing involve shared resources while other features do not, with the research into language switching by bilinguals, presents an interesting challenge. Showing that the same brain areas are active when an individual is engaged in using either of their two (or more) languages does not imply that those brain areas are doing the same thing in both cases. As Anderson's (2014) neural reuse hypothesis points out, the same brain area can be recruited to perform difference tasks on different occasions. There is some early evidence that this is the case when bilinguals are processing one or the other of their known languages. Nichols,Gao, Liu, and Joanisse (Submitted) use Representational Similarity Analysis (RSA) to show that areas within the language networks of English-Mandarin bilinguals that have the same amount of activation when hearing and reading (simultaneously) words in either language, have different patterns of activation.[94] These results suggest that different patterns of activation within the same

[94] RSA is a way of analyzing activation within a region of interest to compare the similarity of the pattern of activation within that brain area. RSA is used to distinguish different patterns of activation within a region when the degree of activation in that region appears the same using standard fMRI interpretations

brain area are used in distinguishing which language is relevant in a given situation.

The absence of a distinct brain region that performs the task of identifying which language is being used presents an interestingly different example of multiple realization from the case of language lateralization. In the case of language lateralization, there were distinct hemispheres of the brain implicated in language processing for different individuals. In the case of bilingualism, there is less evidence for distinct areas of the brain carrying out a task, but instead we see evidence for there being different kinds of processing within a region depending on whether the individual is a monolingual or multilingual. There are distinct kinds of speakers of a given language, monolinguals and bilinguals, that can be distinguished either behaviourally or using pattern classification, according to one research program that seeks to explain the differences between monolinguals and bilinguals (Buchweitz et al. 2012; Nichols 2017; Xu et al 2017). On the other hand, a bilingual speaker of English (and one other language) and a monolingual speaker of English can be grouped together for different purposes (e.g., to study the different ways that they each processes English). When assessing the language abilities of the shared language of a monolingual and a bilingual speaker's first language, there are often no behavioural differences (though, if we look for fine grained differences there may be some ways of telling a bilingual speak apart from a monolingual), yet there are some neuro-physiological differences. So, there are multiple ways of being an English (or any language) speaker.

Again, an analysis of the different realizers of being an English speaker can be given using Shoemaker's account of realization. The mental property being realized in the capacity to speak English (or any other language). To keep this analysis brief, the backward-looking causal power individuative of the property is learning to speak English, and the forward-looking power is the ability to understand and use English. There are two kinds of realizers proposed for this property, bilingual brains and monolingual brains. The core realizer of English in a monolingual brain is activation in the language network, with that activation being considerably greater in the left-hemisphere language areas, whereas

of BOLD signal. The degree to which the pattern of activation in a region of interest is similar (or dissimilar) for distinct experimental conditions is quantified so that the patterns of activation within that region can be compared. The goal of this analysis technique is to characterize the degree to which the region of interest is sensitive to different kinds of information (Kriegeskorte, Mur, and Bandettini 2008).

the core realizer of English in a bilingual brain is distributed activation across both hemispheres, with some distinct patterns of processing in those areas found only in bilinguals. For bilinguals there is the additional process of correctly identifying which known language is presently being perceived even though there does not appear to be a distinct brain area dedicated to that task. There is, in effect, the additional causal property of language separation that bilinguals possess, that distinguishes them from monoliguals. So, there is evidence of both a difference in the brain *areas* and the *activity* in shared areas of the core realizers of the property of being able to speak a particular language when comparing monolinguals to bilinguals.

These ways of grouping individuals based on different language related abilities meet the conditions Polger and Shapiro advance on multiple realization. In particular, the examples of how multilinguals can be grouped based on proficiency or age of acquisition for some purposes, but are kept distinct in other cases is a clear example of how language research meets the third desideratum (See §3.3. for the four conditions on multiple realization Polger and Shapiro refer to as the 'Official Recipe'). In contrast to grouping together individuals based on the number of languages they speak, and then dividing them up based on the age they learned their second language or the proficiency they show in that language, individuals can be grouped together based on which language they speak. To understand how tonal or logographic languages, such as Mandarin, are processed compared to languages that use phonological scripts and do not use tonal cues to signify different meanings, such as English, different ways of grouping language users are appropriate. Moreover, the differences among these groups are not simply individual differences, unlike how varying along a continuum of proficiency could be construed as being, so these examples are not ruled out on the basis of Polger and Shapiro's fourth desideratum.

In summary, I drew upon research into multilingualism to advance two examples of multiple realization. First, there are multiple ways of speaking a second-language, based on difference between high proficiency early and late bilinguals. Second, there are multiple ways of being a speaker of a given language, specifically as a monolingual or bilingual speaker of that language, where the language is the bilingual speaker's L1. These

examples meet the conditions advanced by Polger and Shapiro for examples of multiple realization, and should therefore be accepted as genuine cases of multiple realization. In first case, there is one kind, 'high-proficiency bilingual', according to one way of categorizing second language speakers, but two kinds, early AoA and late AoA bilinguals, according to a different method of classification. So far this means the example has met the first two of Polger and Shapiro's desiderata. As a reminder, the third desideratum requires that, “The factors that lead the As and Bs to be differently classified by S2 must be among those that lead them to be commonly classified by S1.” (Polger and Shapiro 2016, 67) In this case, early and late learners of a second language (the As and Bs classified differently in S2) are high-proficiency speakers of their shared language, and so the fact that they acquired a particular language at some point in their life (early or late) is the reason they are grouped together as speakers of that language, so the example meets the third condition. Finally, the differences between early and late learners are not simply a kind of individual difference. The effects of early acquisition of a second language are important enough that they are studied in their own right. In the second case, there are again two kinds, bilingual and monolingual speakers of a shared language, according to one way of classifying them, and a single kind, speakers of their shared language, classified in another way. Again, the fact that they share a language is a reason to classify them together, and the fact that the bilingual group speaks that language is part of the reason that they are bilinguals, so the example meets the third desideratum. And finally, as I already noted, there are relevant differences between bilinguals' brains and monolinguals' brains, particularly in the case of early AoA bilinguals, so the differences are not merely tolerated individual differences within a kind.

4. 5. Summary

In this chapter I advanced examples from the cognitive neuroscience of language. I presented evidence from a variety of neuro-imaging and cognitive science studies to marshal empirical support for the interpretation that these cases are properly understood as examples of multiple realization. I also pointed to some cases that might appear at first to be examples of multiple realization, but that failed to avoid the objections presented in

the previous chapter.

First, I argued that the study of language lateralization is an example of multiple realization, as the distribution of reading networks in certain individuals. In particular, individuals who show more distribution of their language network bilaterally in both hemispheres of their brain have a noticeably different organization to their language networks than typical cases where individuals show a strong left hemisphere bias to the localization of their reading networks. Second, I contrasted different teaching interventions for individuals with reading deficits. I argued that different etiologies for the same cognitive ability can sometimes be distinguished, and that those cases may count as examples of multiple realization. I concluded that given our present knowledge about the neurological changes that take place while individuals learn to read it remained an open question, to be decided on empirical evidence that may yet become available in the future, whether different etiologies for reading counted as an example of multiple realization. Finally, I discussed research into bilingualism. I argued that there are two examples of multiple realization that could be drawn from research into bilingualism. First, distinctions among bilinguals based on the age at which they acquired their second language show that there are multiple ways of being a bilingual. Second, there are multiple ways of being a speaker of a given language, as a bilingual or as a monolingual.

In light of these examples of multiple realization that have been empirically discovered, I conclude that the pessimism Polger and Shapiro express regarding empirically discoverable (or discovered) cases of multiple realization is unfounded. However, in arguing for the existence of examples multiple realization only on the basis of empirical evidence drawn from the neuro- or cognitive science of language, I must acknowledge that this could be the result of there being something peculiar about language. The discovery of multiple realization of the basis of examples based on cognitive capacities related to language may not generalize outside of cases involving language. The arguments I have made in this paper indicate neither that multiple realization is a general feature of psychological kind, nor that it is restricted to cases involving language.

A final aspect of the debate that I wish to draw attention to is the importance of

empirical evidence to both the defence or rejection of multiple realization. Reliance on empirical evidence distances my defence of multiple realization from traditional arguments about multiple realization. Arguments such as the those advanced in Bechtel and Mundale (1999) (see §3.2.1. in the previous chapter), which interpret multiple realization as cleaving the study of mental kinds from empirical evidence gathered about brains and bodies. Defending multiple realization on the basis of empirical evidence means that there is no such barrier. This opens up the question of how the multiple realization of psychological or mental kinds relates to the study of those kinds by neuro- and cognitive science. Polger and Shapiro have sought to advance an account they call 'Modest Identity' theory, which they describe as a non-reductive version of identity theory.[95] (Polger and Shapiro 2016, 135) Developing a comparably modest version of functionalism, one that remains non-reductive, but that does not lend itself to interpretations that make mental and psychological kinds autonomous from their realizers, is an important next step to pursue.

[95] Modest identity theory is meant to be non-reductive and compatible with limited instances of multiple realization. I review Polger and Shapiro's view and argue that the version of identity theory they defend is more similar to functionalism than it is to identity theory, as both views are traditionally conceived (Booth 2018).

Chapter Five: Conclusion: identity theory, functionalism, new mechanism, structural kinds, and functional kinds

5. 1. Introduction

In the third chapter I presented several arguments against the possibility of multiple realization and defeaters to cases of multiple realization. Those who deny multiple realization are not merely offering a negative thesis. For some their goal is to make room for reevaluation of identity theory. In my concluding chapter I begin by considering why, despite the general acceptance of the argument against identity theory from multiple realization, one might be tempted by a revived version of identity theory. In particular I focus on Thomas Polger and Lawrence Shapiro's work aimed at undermining credence in the multiple realizability of mental kinds to make room for a view they label a “modest identity theory.” (Polger and Shapiro 2016, 219) I propose that Polger and Shapiro's account can be framed as an attempt to argue that identities hold between mental kinds and structural kinds. Though, as I note later on in the chapter, the type of identities they propose are not strictly between mental kinds and structural kinds, but between mental kinds and activities that occur within particular structures. Part of the discussion in this chapter touches on the way that descriptions of mental kinds has changed from talk about static states to talk of dynamic or active processes. The change in the language used to describe mental kinds is paralleled by a change to the way that neural and brain kinds are described; rather than talking about 'brain states' it is more likely physiological facts about brain kinds are described as 'neural activity' or 'activation in a brain area/neural network'. The dual focus on matter and the activities in which the matter participates (entities and activities) is connected to an influential view that comes out of the philosophy of science known as 'new mechanism'. On this account, appeals to physical systems and the behaviours of those systems to explain the occurrence or presence of phenomena of interest is done by providing mechanistic explanations of target phenomena. I conclude this chapter by contrasting how well functionalism and the multiple realization of mental kinds fits with 'New Mechanism' compared to its fit with Polger and Shapiro's modest identity theory.

5. 2. Modest identity theory and structural kinds

The version of identity theory that Polger and Shapiro advance could be seen as proposing a version of identity theory where mental kinds are identical with structural kinds. And even if this is not their preferred or intended view, it is nevertheless an interesting proposal to consider. To illustrate what such a version of identity theory might look like, consider the contrast with a naive version of identity theory. Such an account equates a mental kind with a particular physical-chemical kind, where the physical-chemical kind is individuated on the the basis of both the kind of material out of which it is composed and the organization of that matter. A simpler version still, one that individuated physical kinds solely on the basis of the material composition of a kind would fail for obvious reasons: the structure of the matter that makes up any physical kind contributes to the causal powers that kind possesses. An alternative version of of identity theory could abstract away from the material composition of kinds entirely and instead propose that mental kinds are identical with structural kinds.

Without going into a detailed analysis of the concept of a structural kind, I take a structural kind to be any kind that is picked out based on the *organization* of the matter that constitutes the entity. Structural kinds are contrasted with physical kinds, which are picked out by the kind of *matter* that makes them up, and with functional kinds which are picked out based on the causal role the kind plays within a system. This provisional description of a structural kind is not meant to suggest that structural kinds are independent of the materials that compose them or the functions that they perform. Some structures can be made out of only a limited range of physical or chemical kinds, e.g. a rope must be made from material that is both sufficiently flexible and that it possesses the necessary tensile strength, or a ladder must be made from material that is sufficiently rigid, durable, and sturdy. Structure and function are also closely related, a functional role can be filled only by some kinds, e.g., those kinds that have a structure and composition that contribute to that kind possessing the relevant causal powers. The way that a structural kind is individuated is distinct from the ways that physical kinds or functional kinds are individuated, but the features individuative of functional kinds, structural kinds, and physical kinds are not independent from each other.

In presenting functionalism, Hilary Putnam discusses structural kinds. His arguments for multiple realization appeals to the concept of a Turing machine, and in describing that way that a Turing machine can be realized, he speaks of structural kinds as the realizers of logical kinds,

> As soon as a Turing machine is physically realized, however, something interesting happens. Although the machine has from a logician's point of view only the states A, B, C, etc., it has from the engineer's point of view an almost infinite number of additional "states" (though not in the same sense of "state" - we shall call these *structural states*). (Putnam 1975, 371)

The structural states that Putnam discusses are the physical realizers of the computational states that dictate the behaviour of a Turing machine. So, Putnam reasons, there is a parallel between the way that mental states are realized by physical-chemical states and the way that computational states are realized by structural states,

> It is interesting to note that just as there are two possible descriptions of the behavior of a Turing machine – the engineer's structural blueprint and the logician's "machine table" – so there are two possible descriptions of human psychology. The "behavioristic" approach (including in this category theories which employ "hypothetical constructs," including "constructs" taken from physiology) aims at eventually providing a complete physicalistic description of human behavior, in terms which link up with chemistry and physics. This corresponds to the engineer's or physicist's description of a physically realized Turing machine. But it would also be possible to seek a more abstract description of human mental processes, in terms of "mental states" (physical realization, if any, unspecified) and "impressions" (these play the role of symbols on the machine's tapes) – a description which would specify laws controlling the order in which states succeeded one another, and the relation to verbalization (or, at any rate, verbalized thought). This description, which would be the analogue of a "machine table," it was in fact the program of classical psychology to provide! Classical psychology is often thought to have failed for *methodological* reasons; I would suggest, in light of this analogy, that it failed rather for empirical reasons – the mental states and "impressions" of human being do not form a causally closed system to the extent to which the "configurations" of a Turing machine do. (Putnam 1975, 372-373)

The computational states of a Turing machine can be realized by different structural states, and if the analogy between mental states and computational states holds, then mental states are realizable by different physical-chemical states.

Polger and Shapiro argue contrary to this that in actuality mental kinds can be realized only by unique physical kinds, due to the constraints on realizing something with the complexity of a mental kind. Instead, Polger and Shapiro argue that, as a matter of fact, the complex mental kinds studied in cognitive neuroscience produce so many constraints on the structures that realize them that any given mental kind will have exactly one structural kind that realizes it. This is the interpretation of Polger and Shapiro's account I wish to consider; a mental kind is identical with a particular type of structure, irrespective of the kind(s) of matter that makes up that structure. This proposal abstracts away from the details of what composes a particular structure, so while it might be the case that structural kinds can be composed of different physical-chemical kinds, this is not evidence for multiple realization. Polger and Shapiro adopt the position that multiple realization doesn't "percolate up," (Polger and Shapiro 2016, 61) i.e., even if a part or component that participates in the realization of a kind is multiply realized, it doesn't follow that the realized kind is also multiply realized. The multiple physical-chemical kinds that can realize a structural kind do not contribute to the possibility that a mental or computational kind realized by the structural kind should be considered to be multiply realizable. According to Polger and Shapiro even though structural kinds can be made out of different physical-chemical kinds, and thus might count as having multiple realizers, mental kinds do not have multiple realizers if the *structural kind* that realizes a particular mental kind can be made up out of different materials. Structural kinds may be multiply realized, assuming there is a relevant contrastive question to be asked regarding the different ways in which a structural kind can be realized, but the variation among realizers applies only when assessing that specific contrast.

Polger and Shapiro's version of identity theory is peculiar in that it appears to have at least as much in common with functionalism as it does with a more traditional version of the identity theory. I have argued elsewhere that their version of identity theory resembles functionalism in many interesting and important ways (Booth 2018). The feature I wish to highlight here is that the criteria with which properties relevant to the individuation of structural or functional kinds are selected is not based on facts about the physical-chemical kinds, but rather on the causal roles those kinds play within the

systems under investigation. This is the same way that mental kinds are distinguished according to many versions of functionalism. Putnam observes that attempts to save identity theory using this strategy effectively accept a functionalist account of the mental,

> And if it be argued that we could modify the notion of a 'physical-chemical state', so that 'physical-chemical state' is preserved under *functional* isomorphism, then this is just to say that what all possible organisms which prefer *A* to *B* have in common is *not* [a] physical-chemical state, in the sense in which that term is understood at present, but *psychological* state. (Putnam 1975d, 428.)

Though Putnam's comment anticipates the move Polger and Shapiro make to defend identity theory, it may not undermine their position entirely, as it is possible that the sense of 'physical-chemical' state has changed. It may be that physical-chemical kinds are grouped together based on their structural and functional capacities.

5. 3. Mechanisms and the importance of understanding the realizers

The proposal that the sense of 'physical-chemical states' that was used to articulate older versions of identity theory and functionalism has changed is not merely an ad hoc manoeuvre to rehabilitate identity theory. Descriptions of mental kinds in terms of states has given way to talk of processes or capacities, and talk of physical or chemical states of the brain has been replaced with talk of neural activity or activation of neural networks. So, while the meaning of 'physical-chemical state' may not have changed, it has fallen into disuse and newer descriptions of both mental kinds and brain kinds has taken its place. The changes in the language used to describe mental kinds and their realizers is reflected in the type of explanations cognitive science, psychology, and neuroscience search for and aim to provide. One popular framework proposed by philosophers of science to characterize the goals of those sciences is that they seek to provide mechanistic explanations of their target phenomena. Called 'new mechanism' this research program argues that researchers aim to discover, describe, and understand the composition and operation of mechanisms that produce phenomena of interest.[96]

[96] The contemporary research program in the philosophy of science that focuses on analyzing scientific explanations and practices in terms of mechanisms is known as 'new mechanical philosophy' or 'new mechanism' to distinguish itself from historical versions of mechanical philosophy such as the views expressed by Thomas Hobbes (2008) or René Descartes (1972).

The importance of mechanistic explanations of mental phenomena and the different perspective new mechanism adopts with respect to the explanatory goals and resources of relevant sciences involves a change in the language used to discuss mental kinds and their realizers. The shift in what philosophers consider as constituting the explanandum and the explanans in psychology, cognitive science, and neuroscience represents one way that new mechanism prompts philosophers to revisit the debate between identity theory and functionalism. If the concepts used in mechanistic explanations support positing identities between mental kinds and physical kinds, identity theory receives some indirect support. This illustrates one way that the debate between defenders of identity theory and functionalism is connected with the interest in mechanistic explanations. Before I give a short overview of the some of the features of the new mechanistic account of mechanistic explanation, I raise a second avenue that connects the debate between identity theory and functionalism with new mechanism.

The second connection between new mechanism and multiple realization has to do with the use of empirical evidence, in particular, case studies drawn from cognitive science and neuroscience, in the debate between identity theory and functionalism. I want to highlight that evidence of multiple realization for the examples in the fourth chapter was gathered using current methods or techniques from neuro- and cognitive science, the types of methods that are allegedly ineffective if mental kinds are multiply realized. Many of the arguments against multiple realization appeal to the idea that contemporary methods used in neuroscience and cognitive science are at odds with the possibility of multiple realization, but rather than finding that those methods are in conflict with the multiple realization of mental kinds, it is through the application of those methods that multiple realizers of mental kinds are discovered. So, claims that the successes in neuroscience or cognitive science are incompatible with multiply realized mental kinds are false. One of the successes is the identification of multiple realizers of some mental kinds. Nevertheless, the apparent incompatibility between the multiple realization of mental kinds and research methods or results in neuro- and cognitive science seems to have lasting intuitive appeal. Despite the decades of disfavour into which identity theory fell, it retains the impression that it fits more readily with scientific explanations of the

mental than functionalism does.

This points toward a challenge to which defenders of multiple realization should respond: how does multiple realization fit with the successful research methods used in current neuroscience and cognitive science? In other words, how can it be the case that mental kinds are sometimes multiply realized, but nevertheless investigative techniques that assume the falsity of multiple realization are successful? The prevalence and popularity of claims that attribute cognitive functions to brain areas (e.g., the fusiform face area or the visual word form area) makes it appear as though identity claims are common place in the mind/brain sciences. Even if these identity claims are only provisional or heuristic in nature, the fact that they have led to success or progress in understanding the ways that neural activity realizes mental activity lends indirect support to the hypothesis that the mental kinds are identical with the brain activity that has been identified.

More generally, this presents a challenge for those who defend the view that there are multiply realized mental kinds. They must not merely argue in favour of multiple realizability, and provide examples of multiple realization, but also explain why identity claims can apparently perform important explanatory work in the sciences that investigate psychological and mental kinds. There must be an alternative explanation for the success of these research programs and techniques, advanced by the defender of multiple realization, to explain their success. And this explanation had better not undermine the possibility that mental kinds are multiply realized. Or, to re-frame the goal as a positive requirement for an account of mental and psychological kinds, there should be an account of how multiply realized (or realizable) kinds fit into scientific investigations that involve those kinds. Such an account should explain both how multiply realized kinds are discovered and investigated. It should have something to say about how multiple realizers of a kind are discovered, and once discovered, how the different realizers are investigated separately, and how a multiply realized kind is investigated knowing that there is this type of variability for its realizers. The account of multiply realized mental kinds should provide guidance for how research can proceed in cases in which a multiply realized kind plays a role in a system where the multiply realized kind is not a direct target of

investigation. All of which points to the need for an account of realization that allows for an explanation of why and how the implementation, constitution, or structure of realizers influences or impacts the realized kinds.

The new mechanistic framework is another program of research in the philosophy of science that provides a different starting point for answering questions regarding the role the composition, structure, and activity relevant components play in producing a phenomenon. 'New mechanism' refers to a position (or closely related constellation of views) in the philosophy of science, though it is most prominent in philosophy of neuroscience and biology, that explores, characterizes, and investigates the search for mechanistic explanations of phenomena (particularly biological, psychological, or mental phenomena). The core presentation of the framework of new mechanism comes from Peter Machamer, Lindley Darden, and Carl Craver's "Thinking about Mechanisms." (2000) Central to Machamer, Darden, and Craver's (shortened hereafter to MDC) account is their description of what a mechanism consists in, "Mechanisms are entities and activities organized such that they are productive of regular changes from start or set-up to finish or termination conditions." (Machamer, Darden, and Craver 2000, 2) MDC's account of what constitutes a mechanism gives equal weight to the role that entities and activities play in producing target phenomenon.

Following MDC's watershed paper there have been many different explorations of the applications of this framework, among which are the works of two authors I want to draw connections to, Carl Craver's *Explaining the Brain: Mechanisms and the Mosaic Unity of Neuroscience* (2007) and William Bechtel's *Mental Mechanisms: Philosophical Perspectives on Cognitive Neuroscience*. In Craver's (2007) work he argues that the goal of identifying and understanding mechanisms provides a unifying ideal in the neuro- and cognitive sciences.[97] In §2.3. I mentioned Craver's view on how boundaries and levels within and between mechanisms are defined. Craver's views have also been mentioned at several other points throughout my dissertation, Craver's (2004) work came up in §3.3.3.,

[97] A discussion of the goal of providing a normative or descriptive account of the epistemic practices in cognitive science and neuroscience is outside the scope of my dissertation. I am neither endorsing nor disagreeing with Craver's account of how the search for mechanisms achieves methodological unity in the mind-brain sciences.

where Polger and Shapiro appeal to the *No Dissociable Realization* principle that Craver considers and rejects, and in §4.2. where Khalidi's account of natural kinds is compared to Craver's (2009) simple causal theory of natural kinds. The number of different places in my dissertation where Craver's work dealing with mechanistic explanations of phenomena in neuro- and cognitive science has come up suggests there is a connection between new mechanism and realization. I will not enter further into particular details of Craver's account here.

Bechtel's account of mechanistic explanation has three main aspects. First, he gives an account of how mechanisms are individuated. They are defined relative to the explanandum phenomena; the manner by which a mechanism is individuated depends on how a target explanandum phenomenon is selected or individuated (Bechtel 2008, 13-14). However, the way that an explanandum phenomenon is individuated and characterized may change based upon investigation into the mechanism(s) that explain the phenomenon (*Ibid*, 14; see also Bechtel and Richardson 2010, Ch. 8).[98] The second aspect of mechanistic explanation that Bechtel discusses looks to the way that researchers discover which entities and activities are responsible for a phenomenon ('responsible for' can plausibly be re-read as 'realizers of'). To this end, Bechtel discusses strategies or heuristics used by researchers investigating mechanisms. He explains how decomposition, or near decomposability, of a mechanism into distinct and ordered parts and operations guides researchers in their understanding of how a mechanism produces a phenomenon.[99] The other strategy Bechtel focuses on is localization, which he describes as the attribution of particular operations to specified components within a mechanism. Third, Bechtel points out that the organization, or structure, of a mechanism, is important to understanding its operation. That is, one cannot simply label the constituent parts of a mechanism and then list the actions each part of the mechanism is capable of performing; to properly characterize a mechanism, the relations between its constituent parts, the order of

[98] Changes to the way that a phenomenon is conceptualized based on investigation into that phenomenon is called 'reconstituting the phenomenon' by Bechtel and Richardson (2010). This process could be rephrased in terms of realization as follows: the individuation of a realized kind may come to be thought of differently based on discoveries about the supervenience base of the realized kind.

[99] Bechtel divides decomposition into two sub-kinds, *structural decomposition* and *functional decomposition*. Structural decomposition focuses on individuating the entities that make up a mechanism and functional decomposition applies to the individuation of the activities occur during the operation of the mechanism (Bechtel 2008, 14).

the activities in which the parts engage, and the way that the constituent entities participate in the activities that occur in the relevant order must all be identified and described. A mechanism is a collection of component entities that are assembled with a specific structure and those parts participate in a series of activities, where both the spatial and temporal relations between the constituent entities and the activities affect the mechanism's production of a target phenomenon.

In the next section I advance some open-ended questions regarding the fit between new mechanism and multiple realization. I consider whether mechanisms can be thought of as structural kinds, and what it would mean if mechanisms, qua structural kinds, are the realizers of mental kinds. Taking the view that mechanisms are the realizers of mental kinds provides a way of relating the facts about a realizer to the understanding of the mental kind being realized. A mechanistic understanding of a phenomenon doesn't undermine the explanatory role that phenomenon plays, nor does a mechanistic explanation of a mental kind (process, capacity, or ability) undermine the ontological legitimacy of that mental kind. In this section I also mention a potential tension between new mechanism and the avowal of multiple realization based on arguments by Bechtel and Mundale (1999) and Bechtel (2012). I respond to these concerns by pointing out how the account of realization I explore in my dissertation resolves them. In the final section of this chapter I provide an overview of the chapters of the dissertation.

5. 4. New mechanism, functionalism, and multiple realization

The most obvious connection between functionalism and new mechanism is the view that mechanisms are the realizers of mental kinds. Drawing on Shoemaker's account of realization, a mechanism realizes a mental property if the mechanism possesses the causal powers individuative of the relevant mental kind. Individual entities and activities that compose the mechanism may, on their own, not possess the causal powers individuative of the mental kind and it might be the case that the mechanism itself must be embedded within a larger system for it to realize the relevant mental kind, all of which is consistent with Shoemaker's account of realization. There are many question that can be asked once this position is on the table, in particular I call attention to the following:

- Can multiple mechanisms realize the same mental kind? (Or more generally, can multiple mechanisms realize the same phenomenon?)
- Can a mechanism be multiply realized?
- Can a mental kind be identical with a mechanism?

As I remarked in the introduction of my dissertation (§1.2.2.1.), there are different versions of the multiple realization thesis. Put in terms of mechanisms these views are:

a) It is conceivable that multiple different mechanisms realize the same mental kind,

b) It is metaphysically possibly that multiple different mechanisms can realize the same mental kind,

c) It is nomologically possible that multiple different mechanisms can realize the same mental kind,

d) Multiple different mechanisms infrequently realize the same mental kind in the actual world,

e) Multiple different mechanisms realize the same mental kind, but only in special or particularly constrained circumstances,

f) It is commonplace that multiple different mechanisms realize the same mental kind.

The first three options, a-c, seem to be generally acceptable, and fit with some descriptions of mechanistic explanations. Craver (2007) described two steps in producing mechanistic explanations. First a series of possible or potential entities and activities that *could* produce the target phenomenon are hypothesized, which Craver calls *how-possibly* explanations. Next, through various interventions, experimenters test whether some of the proposed *how-possibly* mechanisms accurately describe the real physical system. By discovering whether there are changes to the behaviour of the mechanism based on interventions that help to identify parts, both entities and activities, of the operation of the mechanism is researched, and the *actual* entities and entities are discovered. Through this process of going from *how-possibly* explanations to *how-actually* descriptions of actual mechanism experimenters move from considering hypotheses consistent with a)-c) to identification of a mechanism(s), which can be used as evidence for or against d)-f).

Despite the apparent good fit between new mechanism and multiple realization as both an empirical hypothesis and a conceptual possibility, there are some proponents of new

mechanism, e.g. Bechtel and Mundale (1999) or Bechtel (2012), who deny that the same mental function can be realized by different mechanisms, because a difference in the mechanism results in a difference in the function that mechanism performs.[100] The arguments against the possibility of multiple mechanisms realizing the same kind that Bechtel (2012) advances draw on considerations raised by the Grain Argument and Shapiro's Dilemma. I addressed both arguments already (see §3.2.1. and §3.2.2.), and will not rehearse my replies here. However, Bechtel also makes the suggestion that the use of models (specifically model organisms used in the research of genetic mechanisms) requires the conservation of the same mechanism across different contexts. This is a version of the idea that if kinds are multiply realized there is little to be gained by investigating particular realizers. On such a view it will not help our understanding of the general kind to understand the operation of a particular kind of realizer because of the variability among those realizers. Regarding biological mechanisms, Bechtel argues that even when the components of different instances of a mechanism that are found in different kinds of organisms (which, in other contexts might lead one to think there are multiple different mechanisms) are distinct, but the structure of the mechanism remains stable and the lineage of the entities in which the mechanism is found can be traced to a common ancestor, then such a case does not constitute an example of multiple realization.[101] (Bechtel 2012, p.59) The main thrust of Bechtel's argument is that

[100] Bechtel specifically comments that differences among mechanisms must result in *some* differences in the behaviours that result from those mechanisms, "So far I have addressed the multiple realization challenge by considering how differences in the mechanism manifest themselves in behavioral differences, thereby questioning whether it is the same phenomenon that is in fact realized." (Bechtel 2012, p.54) The assumption that Bechtel is making is that the causal differences between different mechanisms must be relevant in the individuation of *both* the mechanisms and the phenomena those mechanisms realize. In setting up the supposed tension between multiple realization and mechanistic explanation Bechtel goes so far as to comment that if phenomena are multiply realizable, then mechanistic explanations are doomed to fail, "Recalling that multiple realization was viewed as a problem for identity claims required for reductionistic research, there would seem to be a direct way of presenting these problems within the framework of mechanistic explanation. Indeed, it would seem to constitute a death knell to mechanistic explanation." (*Ibid*, p.50) I am in agreement that the framework of mechanistic explanation presents an opportunity to clearly present why identity theory and multiple realization are at odds. I take issue with the claim that if some phenomena are multiply realized it is impossible to construct or discover mechanistic explanations.

[101] This argument resembles one of the strategies Polger and Shapiro use to explain away cases of multiple realization: Convergence and Homology (Polger and Shapiro 2016, 179-180). I do not deal with this issue, as there are no other animals other than humans that have the relevant kind of language abilities and so no possibility of using other animals as model organisms to study the relevant language phenomena.

once a mechanism is in place and performing a particular function, then changes to the component entities and activities of the mechanism that do not change what function the mechanism performs do not count as reasons for thinking that the mechanisms in different organisms are different in kind.

This argument could be put to use justifying the principle Polger and Shapiro advance that differences among the constituent components of a realizer don't 'percolate up' such that the mechanisms that contain those different components count as different realizers of the same kind (Polger and Shapiro 2016, 61). However, this argument relies on the notion that the preservation of a relationship between a *function* and a *structure* is enough to ground an identity claim. But, this ignores the original thrust of the argument from multiple realization. Abstracting away from lower level facts about the physical constitution of entities, so that entities can be grouped into kinds based on their causal roles, is the core of functionalism. Putnam's reminder that changing the meaning of 'physical-chemical state' so that its meaning "is preserved under *functional* isomorphism" (Putnam 1967d, p. 428) won't save identity theory applies equally to this new argument. If two organisms are said to share a mechanism that realizes the same property in those organisms just because those organisms share a structure that possesses the relevant causal powers individuative of the functional kind, but the structure itself is physically different in the two organisms, then this is not evidence against functionalism or the argument from multiple realization. Rather, this view is the result of accepting the conclusion of the argument from multiple realization; some kinds are legitimately unified because they share functional properties. Unlike the way that the argument from multiple realization undermines identity theory, the fact that the same mechanism can be made up of different sub-components is *not* a barrier to the success of mechanistic explanations of a target phenomenon.

The lack of tension between mechanistic explanation and the possibility of variability in the constitution of a mechanism points to why the multiple realization of some mental kinds has not been a barrier to successful investigation of those kinds using the techniques of neuroscience and cognitive science. The causal powers that are used to individuate the kinds we choose to investigate rarely include the entire set of causal powers an instance of that kind would possess. In selecting or describing the sets of causal powers that are individuative of

functional kinds, we choose to focus on particular causal powers and abstract away from others. Because only *some* of the causal powers are individuative of the kinds we choose to investigate, the door is left open for the possibility that more than one type of physical system could generate that set of causal powers.[102] But this is not an obstacle to investigating any particular system, so the success of scientific investigations doesn't proceed successfully despite multiple realization. The argument from multiple realization reminds us that the way that we individuate kinds depends on choices we make about *which* causal powers are important to our investigation, and which are not.

The way that target phenomena are individuated applies to the way that components of mechanisms are individuated as well, since the components of a mechanism in one context can be individual targets of investigation in another. Recall that the levels within a mechanism are defined only relative to that mechanism (Craver 2007). As the discussion of Khalidi's account of natural kinds illustrated, a simple causal account of natural kinds allows for multiple realizers of the same kind (see §4.1 and §4.2). Discovering that different structures can realize the same phenomenon or discovering that the same structure can be composed of different materials are both empirically possible, and as the examples from Chapter Four illustrate, this kind of variability is discovered in the course of investigations in cognitive science and neuroscience. Discovering that a kind has multiple realizers is valuable both in furthering the abstract and scientific understanding of that kind as well as for particular purposes with respect to how we are able to use or engage with that kind.

5. 5. Summary

The purpose of my dissertation has been to investigate the role that the concept of

[102] Polger and Shapiro object to the idea that the everyday kind of variation described here counts as 'genuine' multiple realization. They insist that genuine multiple realization requires something more mysterious than the variability among kinds I have described. “Sciences, as we shall emphasize, may form their taxonomic kinds in many different ways. The world is full of variation, it is true; so there are many boundaries that might interest a scientist. But multiple realization is a special kind of variation between kinds. The reason that not all variation in nature counts as evidence of multiple realization is that not any sort of variation can perform the numerous jobs for which multiple realization has been recruited.” (Polger and Shapiro 2016, p. 40) The job that Polger and Shapiro believe multiple realization must be able to perform is establishing the autonomy of realized kinds from the study of their realizers. However, as I have shown there are relevant desiderata for an account of realization, and account(s) of realization that meet those desiderata, which do not require of realization that it divorce the study of higher-level kinds from the investigation of the realizers of those kinds.

realization plays in understanding how the mind and brain are related. I began by reviewing the history of the use of the concept of realization and from that proposed three desiderata that an account of realization should meet,

1. The realization relation should support physicalism,
2. Whether a mental kind is multiply realized should be decided on empirical grounds,
3. The account of realization should avoid the causal exclusion problem.

Realization is a relation between mental or psychological kinds, and physical kinds. As such, an account of realization should situate and preserve the causal role(s) that mental/psychological kinds play in the physical world (the only world that there is). While making the connection between mental kinds and their physical realizers clear, an account of realization should *not* rob mental kinds of genuine causal powers. By grounding mental/psychological kinds in the physical world of causes, the importance of empirical evidence in describing mental kinds and their realizers is unavoidable. Arguing that any particular mental kind *is* multiply realized is an empirical claim, and must be supported or refuted based on empirical evidence. The use of empirical evidence, rather than a focus on conceptual arguments for or against the possibility of multiple realization, represents a shift in approaches to questions about realization and multiple realization of mental kinds.

In the second chapter I reviewed and defended Sydney Shoemaker's account of realization as a proof of concept that an account of realization can meet the desiderata I advance. The desiderata are minimal criteria that an account of realization should meet, though as the objections I took up illustrate, even meeting those three desiderata is not a trivial task. By meeting the desiderata, Shoemaker's account qualifies as a potential candidate for these more demanding tasks. However, other accounts could meet the desiderata, or an account which speaks to these other goals could be developed based on the aspects of Shoemaker's account that are used to meet the desiderata.

In the third chapter I presented several critiques of multiple realization, or cases thereof, that draw upon research in neuro- and cognitive science. One general tack that has been taken by these critiques is to press the view that if mental or psychological kinds are multiply realized, then many of the scientific techniques and research programs or

pursuits in the mind and brain sciences would not be as successful as they have been. Given the success of these techniques and research programs, there is reason to be suspicious that mental kinds are multiply realized. I split the arguments against multiple realization into two broad categories, those arguments that object to the possibility of multiple realization, and those that undermine multiple realization by discrediting particular examples of multiple realization. There are, in effect, conceptual arguments against the *possibility* multiple realization and empirical arguments against *instances* of multiple realization. Though the conceptual arguments pose a more general and encompassing challenge to multiple realization, the more limited empirical arguments have garnered more attention because they draw directly upon the constantly developing work in neuro- and cognitive science.

Inspired by the general worry that multiple realization is undermined by contemporary neuroscience, Polger and Shapiro (2016) target particular cases of multiple realization and use specific strategies to explain away alleged cases of multiple realization. They present case studies where they explain away apparent examples of multiple realization with different strategies, then present more generalized versions of those strategies and some guidance for determining which of their strategies might apply in cases they do not discuss. Of their six strategies, I summarized four: Unification, Kind Splitting, Individual Differences, and Abstraction and Idealization. I focused on these strategies as they are the ones potentially applied to the cases I presented in the fourth chapter. These strategies are used, by Polger and Shapiro, to propose ways to realign the classification of mental and psychological kinds. Polger and Shapiro propose that once this realignment is applied, mental kinds are revealed to be identical with corresponding psychological kinds.

In the fourth chapter I responded to the charge that there are no examples of multiply realized mental kinds found by neuro- and cognitive science. The objection against multiple realization based on a supposed lack of empirical evidence *for* multiple realization calls for a simple reply: provide examples of discovered cases of multiply realized mental kinds from neuro- and cognitive science. The examples of multiple realization I describe are such that strategies deployed by Polger and Shapiro do not successfully explain them away.

Specifically, I presented examples drawn from the study of language by psychologists, cognitive scientists, and neuroscientists. I argued that there are several examples of mental kinds with multiple corresponding realizers. These examples are properly examples of the realization of mental kinds by physical kinds, as they fit the account of realization proposed by Shoemaker. They are examples of multiple realization because there is more than one physical kind that realizes the same mental kind. Finally, I showed that these examples are not explained away by the strategies deployed by Polger and Shapiro.

In my concluding chapter I raised a question to which defenders of functionalism owe an answer: How can a functionalist account of mental kinds take seriously the relevance or importance of how knowledge about the realizers of mental kinds contributes to our understanding of the realized kinds? What might an account of the multiple realization of mental kinds look like? Psychology, cognitive science, and neuroscience are practically connected so that the methods and discoveries in each of those fields are used by researchers in the other fields. The success of neuroimaging techniques and other methods of studying neural activity should not be at odds with, or simply irrelevant to, our understanding of the mental kinds that they realize. I raise the possibility that if one thinks of mechanisms as the realizers of mental kinds this might go some of the way to achieving an account of realization and multiple realization where our understanding of the realized kind is enriched by understanding the realizers of that kind. Looking at the way that mechanisms are used to explain phenomena supplements functionalist accounts of mental kinds. Asking what it means for a mechanism to realize a mental kind, how multiple different mechanisms might realize the same mental kind, and whether a mechanism can itself have multiple realizers are all questions that are opened up by connecting a developed account of realization (and multiple realization) with mechanistic accounts of explanation in neuroscience and cognitive science.

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Vita

Name:	Daniel Adam Morrison Booth
Post-secondary Education and Degrees:	The University of Calgary Calgary, Alberta, Canada 2001-2005 B.A. Honours, Philosophy The University of Calgary Calgary, Alberta, Canada 2008-2010 M.A., Philosophy The University of Western Ontario London, Ontario, Canada 2011-2018 Ph.D., Philosophy
Honours and Awards:	Louise McKinney Scholarship, 2003 Jason Lang Scholarship, 2004 Queen Elizabeth II Graduate Scholarship, 2008 Alberta Graduate Scholarship, 2009 FAH President's Entrance Scholarship, 2011
Related Work Experience:	Teaching Assistant The University of Calgary 2008-2010 Teaching Assistant The University of Western Ontario 2011-2015 Research Assistant, Course Planning The University of Western Ontario 2015 Research Assistant, Conference Planning and Organization The University of Western Ontario 2016
Other Publications:	Booth, Daniel. 2018. “Symposium on Polger and Shapiro's "The Multiple Realization Book": The multiple realization book.” *Philosophical Psychology*, Vol. 31, No. 3, 431-445.

Professional Activities:

BMI Lab Associates Program
2012-2015

Presentation, “Replying to the grain argument against multiple realization based on language abilities.”
CSHPS 2016

Presentation, “In defence of a dimensioned subset account of realization.”
CPA 2016

Presentation, “Connectionist models as approximations.”
CSHPS 2014

Commentary, “Sense of Time.” by Gerardo Viera, CPA 2014

Conference Organizer, PhilMiLCog Graduate Conference
2011-2017