A Critique of David Chalmers' and Frank Jackson's Account of Concepts

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Abstract

David Chalmers and Frank Jackson have promoted a strong program of conceptual analysis, which accords a significant philosophical role to the a priori analysis of (empirical) concepts. They found this methodological program on an account of concepts using two-dimensional semantics. This paper argues that Chalmers and Jackson's account of concepts, and the related approach by David Braddon-Mitchell, is inadequate for natural kind concepts as found in biology. Two-dimensional semantics is metaphysically faulty as an account of the nature of concepts and concept possession. It is also methodologically flawed as a guideline for how to study scientific concepts. Proponents of two-dimensional semantics are criticized for not taking seriously semantic variation between persons and for failing to adequately account for the rationality of semantic change. I suggest a more pragmatic approach to natural kind term meaning, arguing that the epistemic goal pursued by a term's use is an additional semantic property.

David Chalmers and Frank Jackson have prominently defended a strong program of conceptual analysis that accords the armchair analysis of concepts without the use of empirical knowledge a central philosophical role (Chalmers 1996, Jackson 1994, 1998). In the case of the empirical concept of consciousness, they have even argued that a priori philosophical analysis shows that consciousness cannot be scientifically reduced to any material features (Chalmers 1996, Chalmers and Jackson 2001). They have based this on an account of concepts and concept possession using two-dimensional semantics (Chalmers 2002a, 2002b, 2004, 2006, Jackson 1998). This essay criticizes Chalmers and Jackson's account of concepts, but my criticism also holds for other proponents of two-dimensional semantics (e.g., Haas-Spohn and Spohn 2001), in particular David Braddon-Mitchell (2004, 2005a, 2005b), who does not make bold claims about a reductive explanation of consciousness but attempts to apply 2D semantics to scientific concepts and their historical change. My contention is first that 2D semantics is *metaphysically* flawed as an account of what it is to possess an empirical concept. 2D semantics makes faulty assumptions about how concept possession relates to the ability to imagine possible scenarios; and by erroneously assuming that concept possession is an a priori ability, the approach neglects rational conceptual change due to experience. Second, 2D semantics is *methodologically* flawed as a guideline for how to philosophically study empirical concepts as found in science. Rather than consulting the intuitions of an individual philosopher, a scientific concept has to be studied in terms of how its use varies within a whole scientific community.

After a brief summary of how the two-dimensional framework construes a concept's content, I turn to a biological case study—the gene concept. Despite being a natural kind term, the term 'gene' has historically undergone semantic change, including change in reference, and even nowadays its semantic properties vary as the term is used by different biologists. Using this case, Sections 3–5 put forward my metaphysical and methodological critique of 2D semantics as an account of scientific concepts. I conclude with sketching an alternative vision of scientific concepts, which to the truth-conditional features of extension and intension adds the epistemic goal pursued by a term's use as a relevant aspect of a concept.

1. Two-Dimensional Semantics

Two-dimensional semantics is a sophisticated framework, with different authors endorsing slightly different variants of it. I present the version of 2D semantics defended by David Chalmers (2002a, 2002b, 2004, 2006), but also by Frank Jackson (1998). Following Chalmers's interpretation of what the two dimensions are, the content or intension I_C of a concept C is a function from a priori epistemically possible scenarios and metaphysically possible worlds to extensions. (An epistemically possible scenario is a way the world could be, for all we know a priori.) $I_C(V, W)$ is the extension the concept has in metaphysically possible world W, assuming that the actual world (which determines the reference of natural kind and other terms) is as laid out by a priori epistemically possible scenario V. The notion of a concept's *A-intension* (also called epistemic intension) refines the traditional idea of possible worlds semantics that a concept's intension is a function from possible worlds to the concept's extension in any such world. The A-intension of concept C is defined as the diagonal $I_C(V, V)$ of the two-dimensional matrix, yielding for each a priori possible scenario V the concept's extension $I_C(V, V)$ in that scenario. The second dimension of $I_C(V, W)$ is important for representing a concept's extension in counterfactual worlds and for assessing modal statements. For the *C-intension* of a concept C (also called its subjunctive intension) is a function from metaphysically possible worlds to extensions, assigning extension $I_C(@, W)$ to each metaphysically possible world W (where @ denotes the actual world).[1]

The A-intension represents the narrow, cognitive content of a concept. It captures the motivation for Frege's notion of sense, namely that co-referential terms (such as 'Hesperus' and 'Phosphorus') may have a different epistemic role. For while having the same extension in the actual world, the overall A-intensions of 'Hesperus' and 'Phosphorus' are different, given that there are some a priori epistemically possible worlds where Hesperus ≠ Phosphorus. In contrast, the C-intension represents the wide content of a concept. For what the C-intension $I_C(@, W)$ is depends on which possible scenario V is the actual world, which is contingent on a posteriori facts (e.g., that water is actually H_2O) that may not be known by the person possessing the concept. In the case of a sentence S, its content $I_S(V, W)$ is a function to truth-values. The sentence expresses an a priori truth if its A-intension $I_S(V, V)$ is true for every a priori epistemically possible scenario V, while it expresses a necessary truth if its C-intension $I_S(@, W)$ is true for every metaphysically possible world W. In this way, 2D semantics makes room and accounts for the difference between the necessary a posteriori and the contingent a priori. Taking the natural kind concept 'water' as an example, in scenario U where the watery stuff is H_2O, $I(U, W)$ is H_2O for every possible world W, while in the a priori epistemically possible scenario V where the watery stuff is XYZ, $I(V, W)$ is XYZ for every possible world W. Thus, the A-intension of 'water' yields extension H_2O in scenario U, and extension XYZ in scenario V. The true statement that 'water is H_2O' is not an a priori truth, as it is false in possible scenario V. The C-intension of 'water' yields extension H_2O for every metaphysically possible world (provided that water is actually H_2O). The statement that 'water is H_2O' is thereby necessarily true.

Apart from capturing the difference between apriority and necessity, another seemingly attractive feature of 2D semantics is that it supports the strong program of conceptual analysis endorsed by Chalmers (1996), Jackson (1994, 1998), and jointly by Chalmers and Jackson (2001). On this approach, possessing a concept is having grasped the corresponding two-dimensional intension. In virtue of possessing concept C, a person is able to tell for any possible scenario V and any possible world W what the concept's extension $I_C(V, W)$ is (Chalmers 2002b, 148). Knowing about the concept's C-intension $I_C(@, W)$

1 'A-intension' and 'C-intension' are Jackson's terms, while Chalmers (2002a) prefers the labels 'epistemic intension' and 'subjunctive intension', respectively (and in earlier work used 'primary intension' and 'secondary intension'; see Chalmers 1996). I use Jackson's terms for sake of brevity.

and the concept's extension in the actual world $I_C(@, @)$ would require the *a posteriori* knowledge of which a priori epistemically possible scenario V is the actual one. But knowledge of the overall two-dimensional intension is deemed to be *a priori*, because one does not need any empirical knowledge about the actual world to tell the value of $I_C(V, W)$ in possible world W given the assumption that the actual world is V. For the same reason, a concept's A-intension, which provides the concept's extension for any a priori epistemically possible world, is also known a priori (Chalmers 2002b, Haas-Spohn and Spohn 2001). This promises a division of labour between philosophy and empirical science. The philosopher can analyze concepts in an a priori fashion, ascertaining the concept's *A-intension* by consulting her intuitions as to how the concept applies in a considered possible scenario. The scientist, in contrast, is needed to figure out which a priori possible scenario is the actual one and how the concept analyzed by the philosopher applies in the actual world. The conceptual analysis by the philosopher is useful because among other things it 'defines the subject' (Jackson 1994), for example, an analysis of the concept 'consciousness' informs us what qualifies as consciousness in the first place (and in any possible scenario), and thus entails whether some empirical findings by cognitive scientists really are about consciousness or some other cognitive phenomenon. By putting forward this two-dimensional account of concept possession, it is explained how and why conceptual analysis and the use of intuitions in philosophy work.

Several previous critiques of 2D semantics concern necessity, rigidity, and the relation between C-intensions and A-intensions (Soames 2004, 2007, Yablo 2000, 2006). My discussion focuses on the notion of an A-intension (as a one-dimensional function from a priori epistemically possible scenarios), as my interest is the semantic properties of scientific terms outside of modal contexts.

2. Semantic Change and Variation of the Term 'Gene'

My discussion uses the gene concept as a case study because of its centrality to biology as well as its semantic relevance. Despite being a natural kind term, the term 'gene' underwent semantic change in the course of history—including a change in reference—and nowadays it exhibits semantic variation as used across different biologists. I shall later argue that two-dimensional semantics is ill-equipped to handle a scientific concept like this.

Biologists as well as philosophers distinguish the classical gene concept established in the 1920s from the molecular gene concept, which originated in the 1960s, growing out of the classical gene concept with the advent of molecular biology (Waters 1994). Unlike later geneticists, classical geneticists had no knowledge about the material structure or internal constitution of genes, apart from them being associated with chromosomes; and in fact, classical geneticists were primarily concerned with studying patterns of inheritance across generations. Classical genes were defined not in terms of their structure, but functionally by their phenotypic effect, where broadly speaking a difference in a chromosomal region between individuals counts as the presence of two different genes if it results in two distinct phenotypes. Thereby the classical gene concept permitted the prediction and statistical explanation of patterns of inheritance, i.e., the distributions of phenotypes in offspring generations.

The advent of molecular biology did not only introduce a novel gene concept, but it also transformed the basic scientific goal of genetics. Rather than studying inheritance across generations, molecular biologists are primarily interested in understanding processes taking place within single cells. The theoretical task of the molecular gene concept is to account for the molecular function of genes—how genes bring about their molecular products. To this end, a structural definition of genes is vital. Gene expression proceeds in two steps: in transcription, a gene's linear DNA nucleotide sequence is copied to an RNA nucleotide sequence (as an intermediate product), which in the subsequent step of translation determines the amino acid sequence of the protein that is the gene's product. Thus, the construal of a molecular gene as a linear sequence of DNA—combined with knowledge about the molecular processes in which it figures—causally explains how this gene codes for the particular amino acid sequence of its protein product.

In addition to a change in the intension of the term 'gene', the transition from classical to molecular genetics brought about a change in the term's very reference. Marcel Weber (2005, Chapter 7) gives a detailed discussion of this instance of semantic change (see also Burian et al. 1996, Kitcher 1982). He argues that what geneticists were tracking when studying 'genes' was not a single structural kind, but that there are several kinds with strongly overlapping yet different extensions, to which biologists can and did refer. Weber introduces the useful notion of 'floating reference' for the idea that the reference of the gene concept has changed constantly during its history, though in a gradual fashion from one category to another category overlapping with the former.[2]

2 "As the practice of genetics continuously generated new ways of detecting, localizing (mapping), and describing genes, some DNA segments moved in, others out of the term's extension. This kind of conceptual change differs substantially from the typical cases that have

To illustrate the difference in meaning and reference between the classical and the molecular gene concept, he discusses the *achaete-scute* gene complex. While detailed classical studies carried out in the 1970s had suggested five classical genes at this locus, molecular research of the 80s instead revealed four molecular genes that are responsible for the phenomena observed by prior classical studies. Since classical genes are individuated in terms of their phenotypic effects and molecular genes are defined as particular structural units coding for proteins, these two concepts may offer a different account for genetic regions with a complex organization.

Rather than giving a detailed account of how the molecular grew out of the classical gene concept, what I want to focus on is the change that the molecular gene concept underwent in the last two decades, and the semantic variation it exhibits nowadays. These scientific developments have recently triggered philosophical discussions of the molecular gene concept, addressing such questions as to whether there is a unified concept underlying the varying uses of 'gene' or whether there are two or more distinct gene concepts used in molecular biology (Beurton et al. 2000, Griffiths and Stotz 2007, Keller 2000, Moss 2003, Stotz and Griffiths 2004, Waters 2000). Back in the 1970s it was assumed that a unique structural definition of molecular genes was possible. In a nutshell, a molecular gene was typically characterized as an open reading frame, i.e., a DNA segment bounded by a start and a stop codon and preceded by a promoter sequence. Such a DNA sequence was assumed to be transcribed to RNA as an intermediate (the promoter initiating this transcription) and then translated to a functional protein as the final product, suggesting that there is a one–one relation between genes and gene products. However, findings in genetics and genomics in the last two decades made clear that gene structure and function is incredibly more complicated in non-bacterial eukaryotes (Stotz 2006, Griffiths and Stotz 2007). The relation between genetic elements and gene products is in fact many–many, and in terms of molecular structure genes form rather a heterogeneous kind, leading to the situation where different molecular biologists offer different definitions and individuation criteria of genes. For the purposes of this paper I mention only one major reason for the current semantic variation, the many–many relation between DNA elements and gene products.

been studied in the physical sciences, such as phlogiston, mass, temperature. The latter terms shifted in reference during scientific revolutions, but were fairly stable at most times. The reference of the term 'gene' was never really stable, and perhaps is not even stable today. Remarkably, this floating of the term's reference seems not to have diminished its theoretical importance or practical usefulness." (Weber 2005, 224)

A continuous DNA segment can give rise to an RNA transcript, where in a process called splicing only some chunks of the RNA are selected and fused to be translated to the protein product, so that only certain parts of the continuous DNA segment actually code for the product. In the case of alternative splicing, different parts of a gene's RNA transcripts can be selected in different cells of an organism or in one cell at different points in time, leading to the situation where one DNA element produces many protein products with distinct amino acid sequences. One could consider this DNA element to be a gene, which happens to code for many distinct products. Or one could postulate a gene for each product, where these genes happen to physically overlap or be identical. There is also a many–one relation between DNA elements and gene products. In the case of trans-splicing, several non-contiguous DNA elements (possibly located on different chromosomes) are independently transcribed to RNAs, which are then fused together to generate a single protein product. This raises the question of whether each of these non-contiguous DNA elements is a separate gene (though each such gene in isolation does not code for any protein), or whether they jointly form a gene (that happens to be physically spread out over the genome). Due to such many–many relations between DNA elements and gene products, it is unclear which DNA elements (and their mereological sums) count as a gene, as a mere part of a gene, or as a collection of several genes. As a result, different scientists may use different criteria for individuating genes, which also entail a different reference of the term 'gene'.

Both the use and the reference of the term 'gene' in contemporary molecular biology can vary across utterances. This is determined by two basic factors. First, genes form a heterogeneous kind, so that different structural and functional features can be used to characterize genes: whether a DNA segment has a separate promoter (not shared with other genes); whether as usual only parts of the coding strand of the DNA double helix are involved, or whether also a part of other, traditionally called 'non-coding' strand of DNA is involved in determining the product; whether causal pathways from genetic elements to gene product branch and/or merge; how chemically diverse the different products produced from a DNA segment are; etc. Second, when using the gene concept on a certain occasion, a biologist has particular investigative or explanatory aims in mind. A geneticist is typically interested in quite specific aspects of gene structure or gene function in her research. Such a research question that is pursued when using the term 'gene' influences which of the possible structural or functional features of genes are relevant for this term use. As a result, two biologists may employ a different construal of what precisely defines a gene when addressing one and the same complex genetic region, simply because they pursue different investigative or explanatory questions when studying this case (and occasionally one and the same person can use the term ‘gene’ differently in different scientific contexts).

3. Conceptual Change

While I will later challenge an account of concepts such as Chalmers and Jackson’s on methodological grounds—as a guideline for how to study concepts—I start with a *metaphysical critique*. Two-dimensional semantics as construed by Chalmers and Jackson endorses an erroneous account of the nature of empirical concepts, or more precisely, of *concept possession*. This becomes particularly plain if one takes a look at episodes of conceptual change in the history of science, which shows that what a concept possessing agent can conceive of changes when the relation of this concept to other concepts changes due to experience. In a nutshell, first, 2D semantics does not provide resources to view the situation where a scientific term changes from one intension to another one as rational. In this sense the account turns out as too weak by failing to account for genuine conceptual change (Section 3). Second, and more importantly, given a particular A-intension associated with a term, 2D semantics makes the empirically false assumption that a person having grasped this intension can tell how the term is to apply to any a priori epistemically possible scenario. In this sense the account will prove too strong by maintaining that an individual can know how a term will apply to any possible future scientific situation (Section 4).

2D semantics assumes that a person possessing concept *C* has (implicit) knowledge of how this concept applies to various possible scenarios, as she has grasped the A-intension of this concept.[3] The concept’s application conditions for different scenarios are a priori in that a person knows them in virtue of possessing the concept. Such application conditions may obtain because concept *C* has connections to other concepts in virtue of its meaning—Chalmers and Jackson (2001) consider them as a priori conceptual connections for this reason. Chalmers (1996) prominently used this framework to argue against the possibility of a materialistic notion of consciousness. Using the framework of 2D semantics, Chalmers analyzes our (folk) notion of consciousness, i.e., the

3 “We can say that a subject grasps an intension when the subject is in a position to *evaluate* that intension: that is, when sufficient reasoning will allow the subject to determine the value of the intension at any world.” (Chalmers 2002b, 148)

A-intension associated with the term 'consciousness'. For example, we can imagine so-called zombies, beings that are physically like us, but lack phenomenal consciousness. In other words, there are a priori epistemically possible worlds where the term 'having consciousness' has an empty extension, though the world is inhabited by beings physically identical to conscious creatures like us. Our concept of consciousness does not have any a priori conceptual connections to any physical concepts—otherwise we could not rationally conceive of zombies. The conclusion that Chalmers (and Jackson) want to draw is that the property picked out by the term 'consciousness' cannot be reduced to any physical property.[4]

To be sure, Chalmers and Jackson (2001) are fully aware of the possibility that future scientists may put forward what they would call a materialistic account of consciousness. On this concept of 'consciousness'—tying consciousness to certain neurophysiological states—it would not be possible any longer to imagine zombies. However, their reply is that this would be a 'change of subject' (Chalmers and Jackson 2001, Jackson 1998). By assumption, such a materialistic notion is a concept distinct from our concept of consciousness, so that in the course of time the term 'consciousness' would simply have switched from one to another A-intension. The contention is that such future scientists would have come to address a different phenomenon (picked out by the new A-intension) when talking about 'consciousness', changing the topic:

> It may even be that in the future, people may come to use a term such as 'consciousness' or 'life' with a priori application conditions that differ from ours, due to sociological or pragmatic factors, or terminological stipulation, or terminological drift. But this sort of future terminological change has no bearing on … any metaphysical or explanatory conclusions that might follow. For example, it could turn out that due to this sort of drift, what someone later calls 'consciousness' can be reductively explained; but that does not imply that consciousness can be reductively explained. (Chalmers and Jackson 2001, 349–50)

In addition to empirical concepts such as 'consciousness' and 'life', Jackson makes the same claim about the concepts of 'knowledge' and 'belief'. For instance, if someone seriously has different intuitions about Gettier cases than

4 Block and Stalnaker (1999), among other critics, point out that while the existence of a priori conceptual connections is a sufficient condition for reduction, it is not a necessary one. A reductive explanation may also be possible once a posteriori background knowledge (e.g., bridge laws between physical and mental entities) becomes available. Legitimate though these objections are, my focus is not on arguments against reduction (put forward by some 2D semantics proponents), but 2D semantics as an account of concepts and concept possession.

us and thus applies the term 'knowledge' differently to some possible scenarios, then she does not possess the (i.e., our) concept of knowledge (Jackson 1998, 32 and 38).

My objection is that while scientists may change the intensions of scientific terms, this need not be an epistemically illegitimate 'change of topic', but conceptual change can be *rational*—the way in which the classical gene concept was transformed into the molecular gene concept is a case in point (Brigandt 2010). Chalmers and Jackson (2001) explicitly deny the possibility of rational conceptual change. For they assume that conceptual content and connections between concepts (specifying a concept's application conditions) are a priori, even if they are causally due to experience. In line with this, they acknowledge that new a posteriori knowledge may *causally* lead to a change of concepts and a priori connections among concepts, but reject the idea that experience could make this conceptual change rational (note their talk about conceptual change being "due to sociological or pragmatic factors, or terminological stipulation" in the above quote, and about "triggering changes" as opposed to rationally justifying changes in the following statement):

> There is no question that empirical information can play a *causal* role in acquiring this knowledge. Empirical knowledge often plays a causal role in the acquisition of concepts with certain a priori connections, and it sometimes plays a role in triggering changes in the a priori connections associated with a term, … But neither of these possibilities entails that [empirical knowledge] *E* plays an essential role in *justifying* knowledge of the relevant conditionals. (Chalmers and Jackson 2001, 346; emphasis in original).

In my view, whether conceptual change is necessarily a change of topic or can be rational has to be settled based on the detailed philosophical interpretation of episodes of conceptual change in the history of science. Chalmers and Jackson maintain their position without having studied actual scientific term use. In contrast, scientists and historians of science assume that the redefinition of scientific terms can be justified. And philosophers of biology have attempted at least in the case of particular concepts to understand the empirical reasons that made their historical change rational. The classical gene concept and the molecular gene concept have different meanings or intensions (A-intensions in the terminology of 2D semantics), which is among other things shown by the fact mentioned in Section 2 that the extensions of these two concepts overlap yet differ. In the course of history the intension associated even with some natural kind terms (at least in biology) has been subject to change, and a philosophical theory of concepts is at a disadvantage if it cannot effectively account for such conceptual change. While unlike Chalmers and Jackson other proponents of

2D semantics may be open to the possibility of rational conceptual change, they still do not provide the philosophical resources to count one A-intension associated with a term as rationally changing into another A-intension.

4. Concept Possession

2D semantics is not debarred from viewing a change in a term's usage as rational, provided that earlier and later uses can be interpreted as being part of one and the same A-intension (Braddon-Mitchell 2005a, 2005b, Haas-Spohn and Spohn 2001). Recall that an A-intension is a function, yielding for any a priori epistemically possible scenario the set of objects to which the term applies in this scenario. Two persons having grasped the same A-intension with a term may use this term differently, simply because of disagreement in empirical beliefs they take different possible scenarios to be the actual one. For instance, assume that past and present biologists have possessed the very same concept (A-intension) of 'species'. (I do not hold this view, but use it to explain a potential option to defend 2D semantics.) For a possible scenario where the groups of organisms that we would recognize as species are lineages of an evolutionary tree, the A-intension may specify that a phylogenetic characterization of species (making reference to the features ensuring a species' cohesion during evolutionary change) is appropriate—in line with contemporary species definitions. For a different a priori possible scenario where the groups of individuals we would recognize as species are not subject to speciation events and have come into being due to divine creation, the same A-intension may mandate a quite different construal of species—more in line with some pre-evolutionary definitions of species. The 2D semantics perspective is that since past and present biologists possess the same A-intension, if an 18th century biologists had considered an a priori possible scenario that is like the world described by current science, he would have seen that the A-intension of 'species' implies a modern construal of species for this scenario (even if he did not take this possible world as actual). If he had come to empirically believe that this possible world was actual, he would have rationally adopted a modern definition and use of the term 'species'. Likewise, if contemporary biologists had to realize that we live in a world where speciation does not actually occur they would rationally change their use of the term 'species' as specified by the A-intension for this possible world, possibly reverting to a historically earlier definition.

This idea bears on some previous critiques of 2D semantics-based conceptual analysis. Laurence and Margolis (2003) object that no *a priori* application conditions exist for empirical concepts such as natural kind terms, citing examples by Putnam (1975). For instance, the stereotypes associated with the terms 'lemon' and 'water' (which are needed to determine to which objects in a possible scenario these terms apply) are open to revision in light of empirical discoveries. Schroeter (2004) points out that even the assumption that an entity is a natural kind can change. Cats could turn out to be robots and thus artifacts rather than members of a natural kind; conversely, pencils originally taken to be artifacts could be discovered to be living organisms (Putnam 1975). Aristotle assumed that fire is one of four basic substances, and thus a natural kind, whereas we have come to realize that it is a process instead (Schroeter 2004). Thus, alleged a priori, meaning-constitutive application conditions are not immune to rational revision in the light of empirical evidence.

These criticisms are well-taken, but the above point about an A-intension being a function yields a possible reply. 2D semantics is not committed to the tenet that the very same a priori application condition (or the very same set of a priori conceptual connections) is to be used for every possible scenario. Different characterizations of the referent (e.g., stereotypes) can be given in different scenarios, and in very different scenarios it can be deemed a different kind of thing (natural kind, process, or artifact). Indeed, while we take cats to be natural kinds (in the scenario we assume to be actual), for proponents of 2D semantics, everyone's intuition that cats could be discovered to be robot-artifacts shows that our A-intension of 'cat' allows for possible scenarios where cats are not members of a natural kind, and our purely a priori grasp of this A-intension mandates that we make this judgment about certain a priori possible empirical scenarios. David Braddon-Mitchell (2005a, 2005b) has used this idea, suggesting that scientists have intuitions as to how biological and chemical kind terms are to be applied in the light of novel empirical discoveries. For instance, biologists consider a taxonomic grouping of several species as natural only if the group is monophyletic, i.e., if it consists of an ancestral species and *all* its descendants. Rats, mice, and guinea pigs used to be considered paradigmatic members of the kind 'rodent'. However, there is some evidence that guinea pigs are evolutionarily quite unrelated to mice and rats, and the smallest monophyletic group containing rats, mice, and guinea pigs also contains horses and primates. These surprising empirical discoveries suggest to change the definition of 'rodent' so as to exclude guinea pigs, to ensure that it denotes a natural group and still includes most of the traditional paradigmatic members. There are other possible scenarios where 'rodent' could not capture any natural taxonomic kind at all. Braddon-Mitchell argues that a concept such as 'rodent' may have a complex, conditional structure, specifying how the term is to be used relative to possible empirical situations (an A-intension), where in some of these situations it denotes a natural kind, while in others it does not.[5]

Thus, substantial historical change in a term's use is in principle consistent with the associated concept being unchanging. The A-intension is stable, and it justifies how the term is to be used relative to a posteriori background beliefs (about which a priori possible scenario is actual). While this idea might deflect the above mentioned criticism by Schroeter (2004) and others that a concept's application condition (including its classification as a natural kind concept) can change based on new empirical discoveries, I present a more fatal flaw of 2D semantics. Apart from the fact that proponents of 2D semantics would have to show that theoretical change in science is usually accompanied by unchanging A-intensions rather than terms switching from one to another A-intension,[6] the vision of concept possession as having grasped an A-intension is false for empirical reasons.

2D semantics as construed by Chalmers, Jackson, and Braddon-Mitchell assumes that in virtue of possessing concept *C* a person can make a verdict for *any* possible scenario as to how the concept applies to this scenario:

> If a subject uses an expression, then given sufficient information about the world, the subject will be in a position to know the extension of the expression. Furthermore, something like this will be the case *however* the world turns out: for any scenario, given sufficient information about that scenario, the subject will be in a position to determine what the extension of the expression will be if that scenario is actual. (Chalmers 2002b, 144; see also Haas-Spohn and Spohn 2001, 300)

5 The concept 'rodent' (its A-intension) may be characterized along the following lines: "'Rodent' is the term for the actual natural taxonomic kind, if any, to which most of the gnawing mammals with no canine teeth and strong incisors and with which humans have been causally acquainted belong, and of which rats and mice are especially paradigm members. It is important to the concept <rodent> that it be a natural group, and it should be as narrow a natural group as possible consistently with including paradigm members. But should it turn out that paradigm rats and mice that have been causally important in history are taxonomically unrelated, then 'rodent' picks out these paradigm creatures as a non-natural kind." (Braddon-Mitchell 2005a, 861)

6 In my view, conceptual change and semantic variation across speakers entail that no clear-cut distinction can be made as to whether a term as used by two persons (at different points in time or at the same time) corresponds to exactly the same or to different intensions. I take formal representations of intensions as mere idealizations. 2D semantics, in contrast, is committed to a clear-cut distinction between same and different A-intensions, insofar as it assumes a dichotomy between an irrational change of topic (in case of a term changing from one to another A-intension) and an empirically warranted change in term use (in case of a term's A-intension being unchanging).

My objection pertains to the very presupposition that an individual has the a priori ability to *imagine* scenarios that would be relevant for analyzing a scientific concept. In order to conceive of a possible scenario—"a maximally specific way the world might be, for all one can know a priori" (Chalmers 2004, 177)—a person must possess various concepts to describe the entities that exist in that world and the properties they have. My point is that one cannot conceive of any scenario a description of which requires (empirical) concepts that one does not currently possess.[7] This includes scenarios that scientists at different points in the future will describe as actual. For science constantly introduces new concepts. Thereby new entities can be postulated, novel properties can be predicated, and new relations (e.g., novel causal processes) between entities can be claimed to obtain. Not just new terms are introduced, but new concepts may change what we can imagine as physically possible. Using our current conceptual scheme we cannot specify scenarios to be described by future science, and thus cannot even conceive of possible future conceptual developments. Even if a person possesses concept *C*, she cannot conceive of such relevant scenarios (due to her lack of other concepts), and a fortiori cannot know how concept *C* applies to these scenarios. This holds even for imagining a partial specification of the *actual* world, which includes facts that have to be described by concepts that future science will introduce.

This fact is shown by the history of science. For instance, if geneticists around 1930 (or philosophers at this time possessing the classical gene concept) had engaged in conceptual analysis, then they would have been debarred from figuring out how their gene concept applied to situations in the actual world as we know and can describe nowadays. For classical geneticists did not know about molecular entities such as promoters, exons, regulatory elements, or spliceosomes, nor did they know about important molecular genetic processes such as translation, alternative splicing, or RNA editing. The objection against 2D semantics is not that past scientists did not *foresee* future empirical discoveries. The objection is that past scientists did not have the concepts in order to *imagine or conceive of* various possible scenarios (e.g., without the concept of splicing one can neither imagine a world in which alternative slicing of RNAs occurs nor one in which it cannot occur). And imagining such scenario is a precondition for deciding how the concept to be analyzed ('gene') applies to it. This is not just a cognitive inability, stemming from to the fact that it is demanding to describe and scrutinize a complete possible world given our

7 Chalmers (2002a, 2002b) uses the notion of a canonical description of a possible scenario, defined as a maximally consistent set of statements. However, he does not discuss how he can avail himself of the concepts that are needed for such a canonical description.

cognitive limitations. Rather, it is a conceptual inability to conceive of (possibly partial) specifications of relevant scenarios. Among the scenarios relevant for a minimal analysis of a scientific concept (such as the gene concept) are those that contain a partial description of the actual world, including facts and possibilities yet to be discovered by future science.

In defense of 2D semantics, one might consider the situation where in 1930 a classical geneticist somehow came to acquire the above mentioned concepts from contemporary molecular biology, so that this person could then imagine various possible scenarios relevant to genetics (one of which is what contemporary geneticists take to be the actual world). A problem with this idea is that the history of genetics illustrates that acquiring a range of collateral concepts (promoters, exons, alternative splicing, …) leads to a change in the very target concept to be analyzed, in this case the gene concept. If the acquisition of these collateral concepts *rationally* demands a revision of the gene concept (the classical gene concept giving rise to the molecular gene concept), then it is not even possible in principle to possess the gene concept of 1930 and at the same time to possess some other concepts from contemporary molecular biology. Jackson and Chalmers would probably insist that concept and knowledge acquisition merely causally (but not rationally) leads to the change of previous concepts, but the history of scientific term use arguably shows that empirical concepts are not purely a priori but embody empirical beliefs and change rationally based on novel experience.

At any rate, there is actually no need to settle whether it is coherently possible to possess the gene concept of 1930 together with other concepts from contemporary molecular genetics. For a classical geneticist did not possess the concepts of molecular biology, and thus as a matter of fact could not imagine the relevant hypothetical scenarios. This directly contradicts the basic tenet of some 2D semantics proponents that in virtue of possessing a concept a person has the ability to pass a verdict as to how the concept applies to possible scenarios. What worlds one can imagine is fundamentally contingent upon the total set of empirical concepts one happens to possess. Even if one is to analyze only one concept *C*, other (collateral) empirical concepts constrain what one can imagine, and they make possible the very ability to imagine scenarios.[8] While Chalmers commits himself to a person being able to tell how the concept applies to *any* possible scenario, my argument still holds for weaker versions of 2D semantics. For we cannot even imagine scenarios that in a few decades will be described by scientists as actual. Such scenarios may not matter when

8 This suggests that the Chalmers's notion of *a priori* epistemically possible worlds—which I above used for the purposes of introducing 2D semantics—is ultimately incoherent.

analyzing the concept 'bachelor', but conceiving of them would be crucial for a two-dimensional account of many scientific concepts such as the gene concept. In summary, individuals simply cannot imagine those scenarios that would be relevant to analyzing a scientific concept, so that the account of concept possession put forward by 2D semantics is empirically false.

5. The Relevance of Semantic Variation

So far I have criticized 2D semantics on *metaphysical* grounds, as a theory of the nature of concepts and concept possession. Now I scrutinize it on *methodological* grounds, as an account of how to study scientific concepts. My complaint is that though proponents of 2D semantics have not denied the possibility of semantic variation, they have not taken this phenomenon seriously and provided tools for understanding it. The semantic properties of biological concepts, including natural kind terms, may exhibit variation within a language community. The structure of this semantic variation is philosophically relevant, so that unlike the method of consulting a philosopher's intuitions as favoured by proponents of 2D semantics, scientific concepts ought to be analyzed by studying their varied uses within a whole language community.

The case study of the current situation of the molecular gene concept (Section 2) illustrated that a natural kind term such as 'gene' may be used differently in different contexts. Different molecular biologists offer different definitions of genes and use different criteria for individuating genes, also resulting in the reference of 'gene' changing between some contexts. Such semantic variation is not only real, but there are epistemic reasons why it exists. Variation in term use can be conducive to scientific practice due to the scientific division of labour. Philosophers typically view concept possession as having certain beliefs (about the concept's referent) and epistemic abilities (the ability to recognize the referent and make inferences), reflected by a concept's intension. Due to the scientific division of labour, various such beliefs and epistemic abilities may be spread out across a whole scientific community, in that an individual scientist usually possesses only a subset of them (while still being able to communicate and participate in research). While one can arguably view a complex scientific concept as shared by many scientists, the possessing of the concept by different scientists may consist in having different beliefs and epistemic abilities, so that a concept conceived of as a communal object exhibits variation internal to it. As a result, a concept need not consist in a *single* A-intension (or however a term's intension is construed), and not everyone possessing the concept need to have grasped *one and the same* A-intension.

Chalmers (2002b, 174) explicitly acknowledges that properly speaking, an A-intension pertains to expression tokens rather than types, and that the A-intension associated with a term can vary across speakers. However, he does not develop philosophical tools to deal with this situation; and if a shift in A-intension is counted as an illegitimate change of subject (Section 3), then the admission that intensions may vary is quite troubling. Methodologically, 2D semantics has not encouraged philosophers to study the variation that concrete empirical and scientific concepts exhibit. No matter whether between-person variation in a term's use is interpreted as being based on one or several intensions (no matter whether a term is viewed as corresponding to one concept exhibiting internal variation or to several related but distinct concepts), the semantic task is to account for how the different uses—possibly different intensions—are tied together, how a term's varying usage is compatible with communication across speakers, and what epistemic reasons make semantic variation persist and possibly conducive to linguistic practice.

Apart from the scientific division of labour, semantic variation is also important for conceptual change. The previous section rejected the tenet of 2D semantics that in virtue of possessing a concept an individual has the ability to know about the concept's extension in various possible scenarios, which could have provided a way for capturing the historical change in a term's use within the 2D framework. However, given that scientists have changed term use in response to novel discoveries (apparently in a non-arbitrary fashion), it seems to be the case that the earlier use of the concept somehow determines how it is to be applied and possibly modified given revised empirical beliefs—just like 2D semantics assumes that an A-intension determines how a term is to be applied to a certain empirical scenario. As mentioned in Section 4, Braddon-Mitchell (2005a, 2005b) has taken this route, claiming that a scientific concept has a complex, conditional structure (an A-intension) that specifies how a scientist is to use the concept relative to possible empirical situations. He suggests that "this structure can be, fallibly, inferred from the way beliefs about the extension of a term change over time, especially in the light of empirical discovery" (Braddon-Mitchell 2005a, 861). My reply is that while there are clearly features that determine how a concept's use is modified in the light of new discoveries, this does not entail that these features are represented by an A-intension, and 2D semantics may in fact fail to capture important determinants of conceptual change. One such factor influencing how a concept will change in the future is the particular *variation* it currently exhibits. The basic reason is that theoretical and conceptual change in science is a *communal* choice. Even if an individual scientist has clear and distinct ideas about how a concept is to be modified given new empirical discoveries, she may be overruled by her colleagues (and legitimately so). A research community as a whole—based on various empirical and theoretical considerations—decides how to react to pressure put on existing concepts by surprising findings. Thus, having grasped an A-intension is not sufficient for a scientist to foresee how the concept is to be applied to future scenarios.

One case where the particular structure of conceptual variation is an important determinant of conceptual change is the term 'homology'. Homology is a traditional and central notion from systematics and evolutionary biology (Brigandt 2011a, 2012). In the second half of the 20th century, the homology concept was integrated into two newly emerging biological disciplines, to wit, molecular biology and evolutionary developmental biology. However, biologists from these new disciplines began to use the concept for their own methodological and explanatory purposes, which diverge from the purposes for which the homology concept has been used in systematics / evolutionary biology. The situation that different biological fields have used the term 'homology' for somewhat different scientific purposes—semantic variation within an overall language community—led to one unified homology concept gradually splitting into three variants, which diverged and nowadays are arguably different concepts, as discussed in detail in Brigandt (2003, 2012). In the case of the gene concept, Section 2 indicated that an important reason for why the term 'gene' is currently used differently within molecular biology is the fact that different researchers may pursue different concrete investigative or explanatory questions when studying genes, focusing on different aspects of gene structure and function—an issue which will be philosophically analyzed below. Given that the presence of community-wide conceptual variation is a determinant of subsequent conceptual change, instead of consulting one's semantic intuitions as a philosopher or the intuitions of a single scientist, understanding why conceptual change occurred in the case of a scientific concept requires the philosopher to study the structure of semantic variation a concept exhibits as used within a whole scientific community.

6. The Epistemic Goal Pursued by a Term's Use

I have argued that the 2D semantics-based account of concepts and concept possession endorsed by David Chalmers, Frank Jackson, and also David Braddon-Mitchell is both metaphysically and methodologically flawed, at least for empirical concepts as found in biology. As an account of the nature of concepts, 2D semantics erroneously assumes that a person in virtue of possessing a concept has the ability to know how the concept is to be applied to any a priori epistemically possible scenario. My argument was that lacking other relevant empirical concepts the person is not even able in principle to imagine many such scenarios (including scenarios soon to be described by future science), while acquiring some these concepts would rationally lead to a change in the concept originally possessed. (And proponents of 2D semantics do not provide the resources of to count a change in a term's A-intension as rational, and may even deem it as an illicit change of subject.) As a methodological guideline for how to study scientific concepts, standard accounts of 2D semantics ignore the relevance of a term exhibiting semantic variation across speakers. Semantic variation is philosophically significant because it may promote the successful use of a scientific term within a research community (due to the division of labour), and because the particular structure of semantic variation is a determinant of conceptual change—which also explains why *an individual* does not have the ability to tell how a concept is to be applied to future scenarios.

In the remainder of this paper I sketch my alternative framework of concepts, which addresses the drawbacks of the 2D semantics-based account of concepts by being able to account for conceptual change and variation. It is a more pragmatic approach to scientific terms, including natural kind terms, as it takes into consideration some of the *intentional and epistemic context* that underlies individual uses of a term. The core idea is to make use of an *additional* aspect of concepts (apart from extension and intension), which I call the epistemic goal pursued by a scientific term's use. A more detailed exposition of this account of scientific concepts together with an explanation of the historical change and current variation of the gene concept can be found in Brigandt (2010), and an application to the homology concept and the concept of evolutionary novelty is given in Brigandt (2012).

It is well-known that scientists pursue various epistemic goals: scientists aim at discovering different phenomena, making scientific inferences and confirming generalizations, and explaining various phenomena. One such epistemic goal (e.g. explaining cell-cell communication) is often specific to a certain scientific field, in that it is pursued by this field (or a class of related fields), while other fields pursue other epistemic goals. Typically, many scientific concepts are developed and used to pursue a given epistemic goal. My point here is that there are cases where an epistemic goal is tied to a single scientific concept, in that the very rationale of introducing this concept and of continuing to use it is to pursue the epistemic goal. For instance, the concept of natural selection is used to account for evolutionary adaptation. Other biological concepts are intended to explain different processes; and still other concepts are not used for any explanatory or deep theoretical purposes, but for the epistemic goal of discovering certain phenomena, as with some concepts from molecular and experimental biology. As indicated in the previous case study, the epistemic goal pursued by the *classical* gene concept is the prediction (and statistical explanation) of patterns of inheritance—a process across generations. In contrast, the epistemic goal of the *molecular* gene concept is to causal-mechanistically explain how genes bring about their molecular products—a process taking place within individual cells. This shows that not only the reference and intension of a scientific term such as 'gene', but also the epistemic goal of its use can be subject to change in history. In sum, the epistemic goal pursued by a central scientific concept's use is the type of knowledge (certain kinds of inferences, explanations, or discoveries) the concept is intended to deliver, given its use by a research community.[9] Associated with such an epistemic goal are standards of what it means for a scientific account or epistemic practice to satisfy it, or standards of what counts as getting closer to this goal.

One reason why the notion of a concept's epistemic goal is relevant is that it accounts for semantic change. A concept (more precisely, its intension) embodies beliefs about the concept's referent. While scientists constantly acquire novel beliefs about a term's referent or even discard previous ideas about the referent, these revised beliefs usually do not lead to a redefinition of the term under consideration. Thus, what has to be accounted for in the case of *semantic* change is why certain novel beliefs about a term's referent (but not others) warranted a change in the very intension of the term. On my account, the *epistemic goal* pursued by a term's use sets the standards for which possible changes in the term's intension count as rational. For instance, a concept's epistemic goal may be to explain certain phenomena, yet presently the concept—reflecting avail-

9 I do not maintain that an epistemic goal can be assigned for every scientific concept. My tenet is that central biological concepts are used to pursue specific epistemic goals. This is sufficient as the notion of epistemic goal is to account for semantic change and variation, which usually only major theoretical concepts exhibit. Moreover, some concepts may also be used for ethical or political goals (Miller 2010), and philosophical concepts can be used for philosophical, e.g., particular semantic or metaphysical, goals (Brigandt 2011b).

able empirical beliefs—does not support an adequate explanation of this kind, e.g., the term's current definition does not include some relevant explanatory notions. Once appropriate empirical insights become available, the concept's definition is revised, and this semantic change is warranted if in virtue of the new definition the concept supports the desired explanation. In general terms, change in a term's intension is rational if the new intension meets the term's epistemic goal to a higher degree than the term's prior intension. If rational change in intension entails a change in the term's reference, the latter is also rational.

This general scheme can be illustrated by the recent history of the molecular gene concept. Section 2 pointed out that in the 1970s a unique and rather simple structural definition of molecular genes prevailed. This characterization of genes as open reading frames seemed to be adequate, as it promised an explanation of how genes code for their molecular products—the explanation demanded by the molecular gene concept's epistemic goal. However, this somewhat monolithic definition has given rise to more complex and varying structural accounts of what individuates genes and which DNA segments are to be delineated as genes. Yet despite a change in the definition and reference of the term 'gene', there is an important element of conceptual continuity. Namely, the epistemic goal pursued by the molecular gene concept is still to account for the molecular function of genes, i.e., how genes produce their molecular products. This stable epistemic goal explains why the term's redefinition was legitimate, and why despite the novel definition there is not are not a change of subject. Among the many new findings about the organization of particular genes and their role in molecular processes, the discoveries that prompted a re-evaluation of how genes are to be defined were primarily those pertaining to the structural basis of gene function. Modern *structural* accounts of genes reflect more appropriately the complex ways in which genes thusly characterized produce their products, thereby providing an improved explanation of gene *function*—as demanded by the concept's epistemic goal. Thus, paying attention to the epistemic goal or scientific purpose for which a concept is used provides a handle on philosophically understanding why a semantic change of the concept was legitimate.[10]

10 Despite the fact that the very epistemic goal pursued by the term 'gene' changed in the transition from the classical to the molecular gene concept, this instance of conceptual change can be understood as rational, as discussed in Brigandt (2010). In Brigandt (2011b), I argue that while an intuition-based analysis of a philosophical concept can make its current intension explicit, the aim ought to be to develop an improved concept (intension). I suggest that the particular philosophical goal pursued by the concept points at the required standards for this. In a similar vein, in the case of the concept of sexual perversion, Miller (2010) argues that apart from our inferential and judgemental dispositions with respect to this concept

The notion of a concept's epistemic goal is also vital for explaining the rationality of semantic variation. The molecular gene concept is used to pursue a basic epistemic goal, common to all researchers using this concept. However, the above case study also hinted at the fact that this *generic* epistemic goal (accounting for molecular gene function) can be spelled out differently by different researchers. In a particular context, a more *specific* epistemic goal is usually in play, where depending on the particular research interest and question, a scientist addresses a specific aspect of gene structure and/or function. For instance, genes as DNA segments are transcribed to RNAs which are translated to proteins; and some molecular biologists (e.g. protein biochemists) focus on protein as the gene product of interests, whereas other scientists (e.g. RNA researchers) may be after RNA as the product relevant in these contexts. Since there is a one–one relation between DNA elements and RNAs, but sometimes a many–many relation between DNA elements and protein products, focusing on the proteins rather than the RNAs produced may lead to different criteria for individuating genes, and may lead to differing accounts (by different scientists) of how many and what genes are located at a particular complex genetic region. Thus, the variation in use of the term 'gene' in contemporary molecular biology results from two factors: the known complexities of gene structure and function, and the existence of different legitimate research interests in the study of genes. Given such a specific epistemic goal, using a broad consensus definition of a gene that includes only those features common to all genes is inadequate to determine how to delineate various DNA elements as genes at a particular genetic region. A more precise characterization of what individuates genes in this case is usually operative in a certain context as it permits a scientist to effectively meet the particular epistemic goal. The flipside of the explanatory advantage of using a precise account of genes is that for other specific epistemic goals, a different precise construal of genes may be necessary, leading to semantic variation across uses of 'gene'.

Given this varying use of the gene concept, one may wonder how communication across different molecular biologists is possible. As in the case of any context-sensitive term studied by philosophy of language, the particular context disambiguates the particular meaning of the term's utterance. In the case of the gene concept, this semantically or pragmatically relevant context may include both the known details of the particular biological case spoken of and the scientific interests (epistemic goal) underlying this use of 'gene'—thereby essentially involving the intentional and epistemic context of communication.

('intension' on my terminology), we also have to take into account the concept's desired social function ('social goal').

Should some actually relevant aspects of the context be unknown to a hearer (or reader of scientific literature), then at least a partial understanding based on broad but minimally widely valid criteria as to what characterizes genes is possible. To be sure, nowadays there are many terms from molecular biology available (e.g. 'exon', 'transcription unit') that can be and are used in different combinations to offer precise descriptions of which aspects of gene structure are talked about, in addition to a mere use of the term 'gene'. Still, rather than eliminating it, the term 'gene' enjoys a widespread usage among biologists, the main reason being that it provides the generality across contexts that scientific theorizing and communication needs. Whereas a very precise combination of several other terms would apply to only some contexts, the term 'gene' provides a trade-off between precision and generality (Brigandt 2010).

7. A Non-Truth Conditional Aspect of Meaning?

In addition to criticizing the account of concepts endorsed by some proponents of two-dimensional semantics, I challenged them for being unable to account for the rationality of semantic change and ignoring the relevance of semantic variation in the case of biological concepts, including natural kind terms. Broadly similar to two-dimensional semantics, my framework of concepts recognizes (1) a concept's extension or reference and (2) a concept's intension or inferential role, but I added (3) the epistemic goal pursued by a concept's use—precisely because the latter accounts for semantic change and variation. The reason is that a temporally stable epistemic goal provides the standard for when a historical change in a term's intension (and possibly extension) is legitimate, and variation in the specific epistemic goal across a term's users accounts for variation in the term's intension.

For a concept's epistemic goal to be (temporarily) stable while its intension changes, and for the epistemic goal to provide the standard for rational change in a concept's intension, the epistemic goal must be a property that is distinct from the concept's intension. Here is an analysis of why this is the case, and why the epistemic goal pursued by a concept's use is not captured by any traditional theory of concepts. Standard semantic theories acknowledge that a term has a referent and an intension. The latter is typically construed in terms of certain (meaning-constitutive) statements about the referent: an A-intension (or an implicit theory characterizing the intension), a definition consisting in a set of analytic statements, or an inferential role, i.e., how the term is used given assumptions about its referent. But the epistemic goal is not about how a concept is used, but what it is used *for*. Whereas a term's intension reflect *beliefs about the referent* and a term's inferential role is how the term is used, the epistemic goal pursued by a term's use is what scientists *attempt to achieve by making use of those beliefs*, by using the term in a certain way, and by tentatively putting forward (and revising) its definition. Therefore, while a definition characterizing the referent is a factual statement, the epistemic goal is a *value*. It is an intellectual aim, and associated with evaluative standards of what it means to get closer to this aim. Moreover, although a scientific concept's reference and intension (e.g., characteristic beliefs about the referent) are representations of the *world studied by science*, the epistemic goal pursued by the concept's use is not even a desire as to how the world studied by science ought to be, it is rather an aim about *scientific practice*.

While it is obvious that the epistemic goal is a pragmatic aspect of term use, and also an epistemic property tied to term use, it may well be controversial whether it is a genuinely semantic property of terms. But not much hinges for me on how to draw the distinction between epistemic and semantic or between semantic and pragmatic. My claim that a concept consists of the three components, (1) its reference, (2) its intension (inferential role), and (3) the concept's epistemic goal, is not so much a metaphysical doctrine about the nature of concepts, but a *methodological* guideline that calls for studying concepts in terms of how a concept changes in history or vary across persons in any of the three components (Brigandt 2011b). Since change in a term's reference or intension role is explained by the epistemic goal of the term's use, all three components of a concept are to be studied *together*. While fulfilling a different philosophical function than the notions of reference and intension, the notion of a concept's epistemic goal is still to be recognized for an important philosophical purpose, to wit, accounting for semantic change and variation. If accounting for semantic change and variation is deemed to be a *semantic* task, and if the epistemic goal—ascribed to a term to fulfill this semantic task—is deemed a *semantic* property of a term, it is a *non-truth conditional aspect of meaning*. The two traditional semantic properties of a term—its extension and its intension—are truth-conditional: the extension of subsentential expressions yields truth-values in a Tarski-style fashion, and the intension of a sentence is a proposition or truth-condition (which can be modeled as a function from possible worlds to truth-values). The epistemic goal pursued by a term's use is clearly not truth-conditional, given that it does not represent the natural world, but is a value / aim for scientific practice.

Acknowledgements

In the development of the ideas laid out in this essay I have benefitted from an unpublished manuscript by Paul Griffiths.

References

Beurton, P. J., R. Falk and H.-J. Rheinberger, eds. 2000. *The Concept of the Gene in Development and Evolution*. Cambridge: Cambridge University Press.

Block, N. and R. Stalnaker. 1999. Conceptual analysis, dualism, and the explanatory gap. *The Philosophical Review* 108: 1–46.

Braddon-Mitchell, D. 2004. Masters of our meanings. *Philosophical Studies* 118: 133–52.

Braddon-Mitchell, D. 2005a. Conceptual stability and the meaning of natural kind terms. *Biology and Philosophy* 20: 859–68.

Braddon-Mitchell, D. 2005b. The subsumption of reference. *British Journal for the Philosophy of Science* 56: 157–78.

Brigandt, I. 2003. Homology in comparative, molecular, and evolutionary developmental biology: the radiation of a concept. *Journal of Experimental Zoology Part B: Molecular and Developmental Evolution* 299B: 9–17.

Brigandt, I. 2010. The epistemic goal of a concept: accounting for the rationality of semantic change and variation. *Synthese* 177: 19–40.

Brigandt, I. 2011a. Essay: Homology. *The Embryo Project Encyclopedia*. ISSN: 1940–5030. http://embryo.asu.edu/handle/10776/1754

Brigandt, I. 2011b. Natural kinds and concepts: a pragmatist and methodologically naturalistic account. In *Pragmatism, Science and Naturalism*, edited by J. Knowles and H. Rydenfelt, 171–96. Berlin: Peter Lang Publishing.

Brigandt, I. 2012. The dynamics of scientific concepts: the relevance of epistemic aims and values. In *Scientific Concepts and Investigative Practice*, edited by U. Feest and F. Steinle, 75–103. Berlin: de Gruyter.

Burian, R. M., R. C. Richardson and W. J. van der Steen. 1996. Against generality: meaning in genetics and philosophy. *Studies in History and Philosophy of Science* 27: 1–29.

Chalmers, D. J. 1996. *The Conscious Mind: In Search of a Fundamental Theory*. Oxford: Oxford University Press.

Chalmers, D. J. 2002a. The components of content. In *Philosophy of Mind: Classical and Contemporary Readings*, edited by D. Chalmers, 608–33. Oxford: Oxford University Press.

Chalmers, D. J. 2002b. On sense and intension. *Philosophical Perspectives* 16: 135–82.

Chalmers, D. J. 2004. Epistemic two-dimensional semantics. *Philosophical Studies* 118: 153–226.

Chalmers, D. J. 2006. The foundations of two-dimensional semantics. In *Two-Dimensional Semantics*, edited by M. García-Carpintero and J. Macià, 55–140. Oxford:

Oxford University Press.
Chalmers, D. J. and F. Jackson. 2001. Conceptual analysis and reductive explanation. *Philosophical Review* 110: 315–60.
Griffiths, P. E. and K. Stotz. 2007. Gene. In *The Cambridge Companion to the Philosophy of Biology*, edited by D. L. Hull and M. Ruse, 85–102. Cambridge: Cambridge University Press.
Haas-Spohn, U. and W. Spohn. 2001. Concepts are beliefs about essences. In *Building on Frege: New Essays About Sense, Content, and Concepts*, edited by A. Newen, U. Nortmann and R. Stuhlmann-Laeisz, 287–316. Chicago: University of Chicago Press.
Jackson, F. 1994. Armchair metaphysics. In *Philosophy in Mind: The Place of Philosophy in the Study of Mind*, edited by M. Michaelis and J. O'Leary-Hawthorne, 22–42. Dordrecht: Kluwer.
Jackson, F. 1998. *From Metaphysics to Ethics: A Defense of Conceptual Analysis*. Oxford: Oxford University Press.
Keller, E. F. 2000. *The Century of the Gene*. Cambridge, MA: MIT Press.
Kitcher, P. 1982. Genes. *British Journal for the Philosophy of Science* 33: 337–59.
Laurence, S. and E. Margolis. 2003. Concepts and conceptual analysis. *Philosophy and Phenomenological Research* 67: 253–81.
Miller, K. 2010. On the concept of sexual perversion. *The Philosophical Quarterly* 60: 808–30.
Moss, L. 2003. *What Genes Can't Do*. Cambridge, MA: MIT Press.
Putnam, H. 1975. The meaning of 'meaning'. In *Mind, Language and Reality: Philosophical Papers, Vol. 2*, 215–71. Cambridge: Cambridge University Press.
Schroeter, L. 2004. The limits of conceptual analysis. *Pacific Philosophical Quarterly* 85: 425–53.
Soames, S. 2004. *Reference and Description: The Case against Two-Dimensionalism*. Princeton: Princeton University Press.
Soames, S. 2007. Ambitious two-dimensionalism. In *On Sense and Direct Reference: Readings in the Philosophy of Language*, edited by M. Davidson, 690–718. New York: McGraw Hill.
Stotz, K. 2006. With 'genes' like that, who needs an environment? Postgenomics's argument for the 'ontogeny of information'. *Philosophy of Science* 73: 905–17.
Stotz, K. and P. E. Griffiths. 2004. Genes: philosophical analyses put to the test. *History and Philosophy of the Life Sciences* 26: 5–28.
Waters, C. K. 1994. Genes made molecular. *Philosophy of Science* 61: 163–85.
Waters, C. K. 2000. Molecules made biological. *Revue Internationale de Philosophie* 4: 539–64.
Weber, M. 2005. *Philosophy of Experimental Biology*. Cambridge: Cambridge University Press.
Yablo, S. 2000. Textbook Kripkeanism and the open texture of concepts. *Pacific Philosophical Quarterly* 81: 98–122.
Yablo, S. 2006. No fool's cold: notes on illusions of possibility. In *Two-Dimensional Semantics*, edited by M. García-Carpintero and J. Macià, 327–45. Oxford: Oxford University Press.