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## **Conceptual Role Semantics, the Theory Theory, and Conceptual Change**

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### **Abstract**

The purpose of the paper is twofold. I first outline a philosophical theory of concepts based on conceptual role semantics. This approach is explicitly intended as a framework for the study and explanation of conceptual change in science. Then I point to the close similarities between this philosophical framework and the theory theory of concepts, suggesting that a convergence between psychological and philosophical approaches to concepts is possible. An underlying theme is to stress that using a non-atomist account of concepts is crucial for the successful study of conceptual development and change — both for the explanation of individual cognitive development and for the study of conceptual change in science.

Even though some psychologists make use of an analogy between individual cognitive development and conceptual change in science, psychological theories of concepts are primarily intended to account for conceptual development in individuals. This paper will first outline a philosophical theory of concepts that is explicitly intended to study and explain conceptual change in science. The main ingredient of my framework is a conceptual role semantics of concepts, which defines concepts in terms of the inferences and explanations in which they figure. Then I will discuss the close similarities between this philosophical framework and the theory theory of concepts. Both approaches agree on the structure of concepts — concepts are viewed as being related to explanatory theories. And both broadly agree on some basic goals of a theory of concepts — the explanation of behavior and conceptual performance, and the explanation of the change and development of concepts, which makes a non-atomist theory of concepts necessary.

## Conceptual role semantics and conceptual change in science

In the past, most discussions in the philosophy of science about conceptual change have focused on the reference of terms.<sup>1</sup> In my view, referential approaches to concepts are of limited use, because concepts or the meaning of terms may change without a change in reference.<sup>2</sup> This limitation of referential is not new to psychologists. Murphy (2002) points out that while referential semantics is very popular in linguistics, it “is not suitable as a psychological theory” of meaning. What we need for the study of conceptual change in science is an account that tells what counts as a change in the meaning of a term

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<sup>1</sup>See Putnam 1973; Devitt 1979; Leplin 1979; Levin 1979; Newton-Smith 1981; Kitcher 1982; Hacking 1983; Sankey 1994; Sankey 1997; Andersen 2001.

<sup>2</sup>Kitcher (1978, 1982, 1993) probably offers the most sophisticated framework on concepts and conceptual change in the philosophy of science. It goes beyond the mere study of reference by introducing the notion of a ‘reference potential’ of a term, which is a proxy for the meaning of a term. I criticize Kitcher’s framework in Brigandt (n.d.a).

and when the change is so substantial that we can talk about the emergence of a new concept (or a split of one concept into two concepts). And this account has to make the explanation of this conceptual change possible. In what follows I will lay out a conceptual role semantics framework that defines concepts in terms of the inferences and explanations in which they figure. The study of conceptual change is thus about the change of the inferences and explanations supported by concepts, focusing on something that matters for scientific change and progress. My account of concepts conforms to the idea that concepts are shared among individuals, that they figure in inferences and explanations, that they change in the course of history, and that content explains the behavior of individuals.

Something like conceptual roles semantics is used by some researchers in cognitive science and artificial intelligence.<sup>3</sup> But it is primarily a theory endorsed by philosophers.<sup>4</sup> Conceptual role semantics (CRS) is not a particular theory, but an approach or a general framework that encompasses different theories. The basic idea of conceptual role semantics (also called functional role semantics) is that the content of syntactic entities and mental representations is at least partially constituted by the cognitive or inferential role they have for a thinker or community. Concepts have a specific role in thought, perception, decision making, and action. As CRS focuses on how content figures in reasoning and rational behavior, it conforms to the idea that the crucial purpose of the ascription of concepts and thought content is to explain behavior, including verbal behavior.

A conceptual role is often defined as the set of causal connections in which a term of

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<sup>3</sup>See Evans 1989; Johnson-Laird 1983; Miller and Johnson-Laird 1976; Woods 1981.

<sup>4</sup>See Bilgrami 1992; Block 1986; Boghossian 1993; Brandom 1994; Field 1977; Harman 1973; Horwich 1998; Jackson and Pettit 1995; Loar 1981; Lycan 1988; McGinn 1982; McLaughlin 1993; Pagin 1997; Peacocke 1992; Schiffer 1981; Segal 2000; Senor 1992; Wedgwood 2001.

the language of thought figures. For the purposes of the study of scientific change we cannot assess the change in the meaning of a term by looking inside the heads of past scientists, but we have to rely on their utterances and writings. For this reason, like some more traditional CRS accounts my framework will spell out the notion of a conceptual role based on public language, without explicitly invoking an inner language of thought. As a first approximation, I define conceptual roles as inferential role. An individual endorses various inferences, and the inferential role of a term T is the totality of accepted inferences between statements in which T occurs. Former CRS approaches focused only on inferences, in fact, conceptual role semantics is often called inferential role semantics. What I want to emphasize is that my notion of conceptual role includes not only the inferential role, but also the *explanatory role* of concepts — concepts can explain certain facts by being part of sentences. Without the concept of natural selection, for instance, we are unable to give a wide range of important explanations in evolutionary biology. It is not obvious how explanation relates to standard models of inference making, so the inferential role of concepts need not encompass their explanatory role. Thus, I define the meaning of a term as the total set of inferences and explanation in which its figures (as being part of certain sentences).

A crucial feature of my approach is that it assumes two levels of content — the level of individuals and the level of linguistic communities. The definition of meaning given so far actually applies to the level of individuals. The meaning of a term in the idiolect of a speaker is just given by the conceptual role, yielding a holist semantics for this first level. Given that probably no two individuals endorse the same totality of inferences and explanations, their conceptual roles of a term T will differ. On my account, individuals usually do not associate the very same meaning with a given term.<sup>5</sup> Acknowledging

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<sup>5</sup>Because this semantic holism and difference in meaning is just a reflection of de-facto difference in belief, it does not immediately run into problematic incommensurability.

this holist, fine-grained understanding of meaning is important if content ascription is to explain behavior. If two scientists have a different conception of genes and thus on my account associate a different meaning with the term ‘gene’, then due to their different conceptions they may make different theoretical claims and conduct different experiments.<sup>6</sup> On the other hand, only a certain part of the total conceptual role is important for a particular situation. A layman and a *Drosophila* geneticist have very different conceptions or ‘concepts’ of a fly. But when we explain how they succeed in catching a fly, we just need to make recourse to a few shared beliefs about flies that are sufficient to explain their behavior, such as the assumption that flies can fly. So holism and variation between the content of individuals does not prevent us from giving intentional explanations. The total conceptual role is an important resource for a whole range of different explanations. Any difference in individual content may feed into some explanation.<sup>7</sup>

But concepts have to be shared, so I use a second level of content. I view a concept as a cluster of similar individual meanings or conceptual roles. Taking a concept as a group-level entity abstracts from the inter-personal variation and focuses on the more substantial difference between different concepts. Thus I follow Harman (1973), Block (1986), and Jackman (1999) in assuming that merely similarity, not necessarily identity in conceptual role is sufficient to share the same concept. In other words, I assume that the content of a concept supervenes on conceptual roles. In particular, two concepts can

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<sup>6</sup>Proponents of CRS often stress the explanatory role of content based on the idea of narrow (as opposed to wide) content. I cannot discuss this issue here.

<sup>7</sup>Fodor (1998, 2001) and Fodor and LePore (1992) argue that holist semantics is incompatible with the compositionality of meaning. I cannot discuss this issue here, but I think we can explain the systematicity and productivity of language without assuming that every concept is compositional (instead we also have to invoke explanatory mental theories to account for conceptual combination). See Robbins (2002) for a good critique of Fodor’s arguments.

be different only insofar they have different conceptual roles.<sup>8</sup> Psychologists usually do not endorse meaning holism, based on the idea that not every possible difference between individuals can amount to a different concept. I suspect that many researchers do not clearly distinguish between my first and second level—the holistic content of individuals and the group-level content that are less holistic and permit shared concepts.

How do I individuate concepts, i.e., when is similarity of conceptual role an identity of concepts? I do not believe in an analytic/synthetic distinction or determinate and unique individuation criteria of concepts. Many philosophers assume that there are clearly delimited senses or concepts that we can grasp, but I do not think that we can reconcile this philosophical intuition with some aspects of concept use in ordinary language and the conceptual and terminological variation that we find in science. On my theory which views concepts as clusters of similar mental representations, there is no ultimate and philosophically interesting matter of the fact whether a certain cluster is really a concept or whether it for instance a subconcept or a conceptual variant of a ‘real’ concept. Instead, for the study of conceptual change in science pragmatic and case by case criteria for the individuation of concepts can be used. I assume that two terms can be viewed as corresponding to two distinct concepts in case they make inferences or explanations possible that are relevantly dissimilar. What counts as relevant is dependent on the scientific standards of the given situation. The concrete scientific situation

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<sup>8</sup>Fodor (1998) and independently Becker (1998) argue that an appeal to similarity of content without identity of content won’t do. The idea is that if two people endorse an inference from the *concept* ‘dog’ to the *concept* ‘animal’, then this seeming agreement is actually not an identity (which could be used to define similarity). For given holism these two people have a different *concept* of an animal, so that they actually endorse two different inferences. The reply to this argument is to point out that my definition of conceptual role is about inferential and explanatory relations between *terms*, words, and utterances, so that the above two mentioned persons endorse the same inference. The fact that basing concepts on similarities of syntactic entities is possible is shown by Goldstone and Rogosky (2002), who present an algorithm that only uses conceptual connections between the terms of one conceptual system to achieve translation between systems.

determines what counts as giving a justification or an explanation that is different in kind from other justifications or explanations. The point of my approach is that while I stress that the variation of individual mental representations is real, the existence of clusters is real as well. And we can pragmatically pick out some clusters for a certain philosophical purpose, and compare these concepts and explain and assess the origin of these conceptual differences. The standard philosophical argument against psychological research having a bearing on the semantics of concepts is based on the idea that psychology cannot offer individuation criteria of concepts and the claim that concepts are normative, in that they tell us how we have to reason, while psychological research can only uncover how people actually reason. I think we dispense with these arguments. Using a cluster theory without immutable individuation criteria is viable and fruitful as long as we can explain the change in the entities picked out as concepts.

Apart from a conceptual role semantics based account of conceptual content, my philosophical framework offers ways of explaining and assessing conceptual change. Conceptual change is explained with reference to the epistemic goals of a particular field or research program. The goals and needs of a discipline put demands on concepts, and concepts are changed and shaped to achieve these goals in a better manner.<sup>9</sup> According to my framework, conceptual change can be evaluated in terms of the way in which it contributes to the goals of a scientific field. A change in the inferences and explanations supported by a concept is progressive to the extent to which it brings about new types of knowledge that a particular scientific branch demands.<sup>10</sup>

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<sup>9</sup>In Brigandt (2003) and (n.d.b) I argue that currently there is a phylogenetic homology concept used in evolutionary and comparative biology that primarily supports inferences. But there is also a distinct developmental homology concept used in evolutionary developmental biology, which is used for explanations. The emergence of the conceptual difference is explained with reference to the goals and theoretical agendas of these two disciplines.

<sup>10</sup>Brigandt (n.d.a) argues that the molecular gene concept supports types of explanations that the Mendelian gene concept does not support.

## Conceptual role semantics and the theory theory

Conceptual role semantics is primarily a hobby horse of some philosophers. However, I view striking parallels between my philosophical framework and some recent developments in psychology, in particular the theory theory of concepts. According to CRS, a concept is defined in terms of connections to other concepts embodying background knowledge. In the last two decades, psychologist realized the importance of *knowledge effects*. Various conceptual performances are sometimes substantially influenced by collateral background knowledge of individuals. Paradigmatic are the findings on folk essentialism in children (Gelman and Wellman 1991), which are explained by attributing domain-specific theories to children (which change during development). Knowledge effects can be found in all domains studied by psychology, so that this influencing background knowledge needs to be linked to the concept in order to be able to account for the conceptual performance (Murphy 2002 reserves a whole chapter for the discussion of knowledge effects). This lead to a critique of the former two dominant theories of concepts, the prototype and exemplar theories, and the development of the theory theory. Like CRS, the theory theory is not a specific doctrine but rather a psychological approach to concepts, encompassing different accounts.<sup>11</sup> The theory theory basically assumes that concepts are representations whose structure consists in their relations to other concepts *as specified by a mental theory*. Thus, conceptual role semantics and the theory theory clearly converge on their accounts about the structure of concepts — concepts are viewed as being related to other concepts and being part of theories.

In my view, theory theorists are in a sense ahead of philosophers because they have emphasized from early on the role of *explanatory* theories in cognition and the fact that

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<sup>11</sup>See Carey 1985; Carey 1988; Gelman and Wellman 1991; Gopnik 1988; Gopnik and Meltzoff 1997; Gopnik, Meltzoff, and Kuhl 1999; Hirschfeld 1996; Johnson and Keil 2000; Karmiloff-Smith 1988; Keil 1989a; Keil 1989b; Keil and Wilson 2000; Murphy 2002; Murphy and Medin 1985.

concepts are used to explain the world around us. Proponents of CRS — as long as they do not talk somewhat unilluminatingly about the causal role of a concept — have usually identified conceptual role with *inferential* role. My framework on concepts is designed to study conceptual change in science, and has to scientific explanations into account, as I view giving explanations the primary intellectual achievement of science. The psychological research helps us to underscore the general cognitive role of explanatory theories and thus the continuity in cognition and reasoning between children, adults, and scientists.

Psychologists favoring the theory theory are still relatively unclear about what a mental theory and thus a concept is. In fact, what is called a theory may look quite different in children and adults at various developmental stages. Conceptual role semantics is in a better position insofar as it can make use of public language and explicit scientific discourse in order to get a grasp on the inferences and explanations endorsed by an individual, which define the content of a term. However, CRS lacks any understanding of the mental processes underlying the linguistic expression of reasoning. And it cannot explain the cognitive continuity between children and adults. Despite the current situation that makes conceptual role semantics and the theory theory look like theories addressing different issues, I assume that future psychological research can shed light on the nature of mental theories and reasoning processes, which in turn might bring about a psychologically based and revised philosophical account of what a conceptual role is so that the gap between psychological and philosophical approaches is reduced.

So far I have discussed similarities in the way CRS and the theory theory view concepts and their structure. One reason for this convergence is actually based on related goals of both approaches. Both accounts agree that one of the reasons of attributing concepts is to explain behavior, including verbal behavior. As already pointed out, a prime motivation for CRS is to explain reasoning and action by means of the concepts

and contents attributed to an agent. Scientists make certain inferences because of the particular concepts they have. In case CRS invokes the language of thought, a symbol in the LOT (corresponding to a concept) has a certain causal role that explains reasoning and action. One goal of psychological theories is to understand how a concept can contribute to the way in which people effectively reason and navigate in the world. This goal delimits what a concept actually is for a psychological theory of concepts and their structure. A psychological theory of concepts has to account for the various types of conceptual performances studied in experiments — categorization and taxonomic organization of knowledge, induction, conceptual combination, and conceptual development. The focus on the explanatory role of concepts explains why both CRS and the theory theory assume that concepts have a rich structure. Conceptual performances may depend on various background beliefs or implicit theories of individuals, so that an account of concepts has to link concepts to theories or other concepts.<sup>12</sup> Assuming that concepts have a rich structure has the additional advantage that we have a way of studying and explaining cognitive development of individuals as well as scientific conceptual change. While it is unclear how atomist can account for conceptual change, CRS and the theory theory can study the change in mental theories or conceptual connections.<sup>13</sup>

There is a further analogy between my framework and some recent developments in cognitive science. In the last few years there emerged a body of literature on *intentional conceptual change*.<sup>14</sup> Psychologists and education scientists realized that if individuals with the same knowledge background and the same intelligence are exposed to the same

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<sup>12</sup>Khalidi (1995) makes a similar point by arguing that the theory theory takes what Dennett calls an intentional stance towards the individual.

<sup>13</sup>Keil and Wilson (2000) criticize Fodor's atomist theory of concepts, because it does not make sense of cognitive development and scientific conceptual change. In his reply, Fodor (2000) does not view the issue of conceptual change as a problem or an issue for a theory of content. So much worse for Fodor's approach.

<sup>14</sup>See for instance the contributions in Sinatra and Pintrich (2003).

information, their intellectual development may still diverge substantially. This can be accounted for by the different intentions that individuals have towards the acquisition of knowledge in specific domains. Some recent studies stress the importance of taking intentions as a determinant of individual conceptual change and development into account. I already pointed out that I explain conceptual change in science with the reference to the goals of a particular field or research approach. The focus on intentions and goals of individuals and groups is probably relevant for explaining conceptual development and change both in individuals and in science.

Psychologists have stressed an analogy between the cognitive development of individuals, in particular conceptual development in children, and the historical phenomenon of conceptual change in science.<sup>15</sup> Some psychologists are inspired by historical and philosophical theories about conceptual change in science and try to employ some of these philosophical ideas for the study and interpretation of the cognitive development of children. Carey (1985, 1988) goes so far that she interprets certain substantial conceptual differences between children and adults as an instance of Kuhnian incommensurability of concepts. Philosophers of science usually caution against taking this analogy too literally or too far.<sup>16</sup> In this paper I cannot address some of the bolder analogies between cognitive development and scientific conceptual change. My discussion already pointed to some similarities between the goals of a psychological and a philosophical approach to concepts, and suggested a possible convergence between a psychological and philosophical account of the nature and structure of concepts. What I want to stress is that I do not view any incompatibility between the psychological and philosophical study of concepts. Despite some differences in the aims of these two fields, there is a good deal of overlap and both approaches to concepts can complement each other.

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<sup>15</sup>Gopnik 1988; Gopnik and Meltzoff 1997; Gopnik, Meltzoff, and Kuhl 1999; Karmillof-Smith 1988.

<sup>16</sup>See Downes 1999a; Downes 1999b; Kitcher 1988.

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