

# Theories of Representation: A Survey

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**Abstract:** Studies on mental representations are on the central stage of current analytic philosophy, and have significant impact on neighboring disciplines. There is a variety of theories proposed and there is no universal agreement on which one is the best. In this paper I survey some representation theories which are currently most influential, with some historical background and my own comments.

**Key Words:** Representation; misrepresentation; intentionality

The theory of (mental) representation is one of the most active and exciting research fields in contemporary philosophy. Together with the studies of consciousness, it is on the center stage in recent studies in philosophy of mind, philosophy of language, philosophy of psychology, and cognitive science. It also has brought revolutionary impacts on traditional philosophical subjects like epistemology and metaphysics, which are core fields of philosophy. Furthermore, theories of representation bear significant impact on studies in other fields such as Artificial Intelligence, Psychology and Linguistics.

Currently there is no theory of representation that is widely agreed upon. Instead, there are different kinds of theories offered in contemporary literature, which come from different backgrounds and address similar problems with different degrees of success. This paper aims to survey and examine the major theories of representation.

## I. Introduction: Landscape of Representations

What is a representation? The phenomenon of representation is pretty complicated. Let's start from some simple examples. A picture of a person is not merely some colored patterns, but represents some person in the world. (That is why it is a picture of *a person*.) Clearly there is a difference between the vehicle of the representation (what is representing) and the object of representation (what is represented).<sup>1</sup> Here the picture itself (made of color spots) is the vehicle of representation while the person is the object of representation. There is also a need of the relation

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<sup>1</sup> There are different names for these concepts in the literatures, especially because these concepts cannot be fully understood without a detailed theory of representation. The vehicle of representation is often called simply as representation, when no ambiguity is at risk. For human mental representation, the vehicle of representation is inside the head. The object of representation needs further clarification. According to a distinction made by Cummins (1996), the object of representation is ambiguous between the object that a representation is representing, and the object the representation aims at representing. The former is given by the relation of representation and is called the content of representation; the latter is called the target of representation. When the target and the content do not match, misrepresentation happens. For example you may misrepresent a distant cow as a horse.

of representation, which connects the vehicle and the object. How can the picture represent a person? It is based upon the relation of representation. In this example the intuitive understanding of the relation of representation is similarity or resemblance. In other words, the picture and the person share some structured pictorial similarity.

Signs are similar to pictures. A sign itself has a particular structure (e.g. a stop sign is red and has a particular shape), but it also represents something else (a stop sign means that you need to stop right here). It is exactly because signs can represent that signs are signs. Signs may resemble objects they represent, but this kind of resemblance is not necessary for the function of signs. Hieroglyphic language (Egyptian, and maybe ancient Chinese language) may utilize picture-like signs to represent objects in the world (e.g. the sun and the moon), but other languages are doing pretty well without the use of pictures. Stop signs have no similarity to the demand of stopping, and the red light does not resemble the action of stopping your car, which is the intended representation. In these cases the relation of representation is derived from convention rather than from similarity. This shows that similarity is just one of many ways to explain the relation of representation. Also similarity between two things alone is not sufficient for one object to *represent* the other object. Two similar pictures represent neither of them. So similarity is neither necessary condition nor sufficient condition for relation of representation.

Sometimes we talk about natural signs contrasted with the above conventional signs. Smoke indicates fire; think dark cloud signals the coming rain; and the loops of a tree represents its age. Here the relation of representation is naturally established – it is based upon a causal relation that does not fail (or almost always obtains). But similar to conventional signs, natural signs do not become signs merely because of the natural causal relation connecting the sign and the signed. The information must be utilized by some agent (the consumer). It must be a sign for someone. If no one watches, the smoke is still causally connected with the fire, but the smoke is not a *sign* of the fire. There are many causal relations in the world, and most of them have nothing to do with representations. Consumer is another necessary component of representation.<sup>2</sup>

Man-made instruments can represent too. The number on a thermometer represents the temperature, the reading on a tachometer tells about the speed of the car, and the odometer represents the distance. How can these instruments represent? They can represent because we have made these instruments represent. They are designed by us to have these functions. It seems that the representation of man-made instruments is derived from human intentions, to which we now turn.

Human language is the most interesting and the most intriguing case of representation. It has interested and puzzled generations of philosophers. A word (either written or spoken) is clearly a representation of something else, which is often of important survival value to us. For example, ‘dog’ means some animal that barks at you (i.e. a dog), ‘apple’ represents apple, something you can eat. It is clear that there is a connection between the word ‘dog’ and the object dog. But how is this connection made possible, and what is the nature of the connection? Language, with its intimate connection to thinking and reasoning, is viewed as a mark that distinguishes human beings from animals. Yet it is extremely difficult to understand how language came to existence and how language works the way it is.

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<sup>2</sup> The notion of consumer plays an essential role in some theories of representation, e.g. in Millikan’s theory. In these theories, consumer is not a mere agent of consuming the information carried by the representation, but plays a role in defining the relation of representation and the content of representation.

Classical approaches start from Descartes' theory of mind, which lays out the foundation for modern philosophy. The core of Descartes' theory is that the mind can only perceive the representation of external objects but cannot directly perceive external objects themselves. In other words, the mind utilizes internal representations that connect us to the external world, of which we do not have direct access. The internal representations are called *ideas* in general. Ideas are transparent to the mind; the mind has direct access to ideas. A further distinction is made between impressions (immediate sense perception) and ideas (memories or products of mental operations on impressions). The naïve picture theory of representation claims that impressions are similar to the external objects that they represent, as if the mind is entertaining mental pictures of external objects (as if a little man is watching a movie in the head). The relation of representation is founded upon similarity (resemblance) relation. In the history of philosophy, this idealistic tendency in Cartesian approach (the intrinsic separation of the vehicle of representation and the represented) is gradually pushed to an absurd extremity by British empiricists Locke, Berkeley, and Hume. The logical consequence of this approach seems to be that there is no justifiable reason to believe that the reality is what the mind represents as it is (for either the primary or secondary properties), that there is any necessary connection between causal events, or that the mind itself actually exists.

This Cartesian theory of mental representation is clearly false, especially given current scientific understanding of the brain. There are no such pictures in the head, and there is no little man sitting there to watch them. It is at most a good metaphor to think of ideas as mental images of external objects. The pictorial similarity is not what connects the ideas to the objects.

Language remains a mystery in the 20<sup>th</sup> century. The movement of analytic philosophy is characterized by various attempts at a thorough understanding of language. Frege and Russell's discovery of modern predicate logic provides a solid foundation for a criterion of analysis of language, and Russell's application of this logic to the problem of the empty definite descriptions (e.g. the current French King) started the movement. Yet more problems are found, and more theories are proposed and many of them go beyond the framework of modern logic. Some theories totally give up logical analysis completely. Right now, even if an agreement has not been widely reached, we have understood the linguistic phenomenon much better than before. We can also better appreciate the strength and the weakness of various approaches, and many philosophers work on a common set of assumptions. This says that the set of problems is getting clearer, and it seems that a general theory of representation is on the horizon.

Recent attentions to representation start at Brentano's analysis of intentionality. Brentano marks a special property of mental phenomena. A belief (or a desire) is a belief (or a desire) *about* something else rather than the belief (or the desire) *per se*. And a belief can be about something that does not actually exist (intentional inexistence). I can think of Pegasus or a gold mountain, which does not exist in the actual world. Brentano thinks that this is the distinctive character that marks mental phenomenon.

It seems that most representations have the above character too. A representation is used to represent *something else*. It is useful not because of itself, but because the information it contains *about* the object represented. For example, a photo is useful (interesting) to us because of the person it represents, not because of the color pattern it has. Also representations can misrepresent, and sometimes a representation can represent something that does not exist. Actually intentional inexistence seems to be a special case of misrepresentation. For example, an instrument like a

tachometer can give you a wrong reading; a traffic sign of “Warning: Deer Crossing” may be put in a place where there is no deer in that region.<sup>3</sup> Does this indicate that there is a closer connection between linguistic representations and other kinds of representations?

There is another kind of representation which may hold the key to any genuine understanding of representation: biological devices. Bee dances together with the location of the sun indicate the location of flowers and drive the other bees (those who are ‘watching’ the dance) there. Bird’s chirpings vary in its pattern and each has its distinctive meaning. A beaver’s splash can warn the other beavers of a potential predator. It seems we can even go a little bit further to attribute more primitive organisms the ability of representing. A butterfly is able to navigate the world pretty well, and this indicates some kind of inner representation of the external world. A frog can catch a fly with an amazing speed of its tongue. Maybe even bacteria can represent. As Dretske (1986) reported, some marine bacteria have internal magnets that align them to a direction parallel to the earth’s magnetic field. This seems to help these bacteria to survive since this enables them to avoid the surface water, which is oxygen rich and so is fatal to these bacteria. In this case, it seems that bacteria can somehow represent the direction of the earth’s magnetic field, and somehow represent the oxygen-free environment.

This finishes our landscape of representations. Is there a general theory to all kinds of representations? It seems impossible to give a definition (a necessary and sufficient condition) of representation that can comprise all the above instances. Actually intuitions vary among different people regarding what can be called representation and what cannot be. But this does not imply that there is not a core part of representation which is a paradigm of our use of representations, and all our other uses are somehow similar to the paradigm. The question is what is the core.

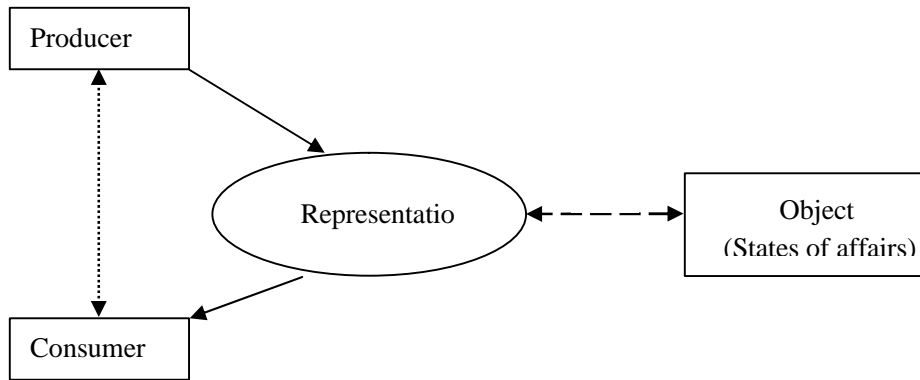
Millikan’s theory is ambitious exactly in this sense. Her theory treats the biological devices as the foundation of a proper understanding of representations. This theory provides a most general theory of representations and seems to fit intuition pretty well. Also it brings a very interesting perspective to the understanding of human language and human linguistic behavior. But this does not mean that her theory does not have its share of problems. There are serious challenges to her theory, just as there are challenges to all other theories. In the next section, I will present a framework of representation, and enumerate various problems that a theory of representation has to answer. In the last part I will introduce and discuss some major theories in the field.

## II. What are Representations?

From the above discussion, we can see quite clearly the following components are necessary for a representation. A representation is produced by a device (producer) and used by a consumer (which could be the same as the producer). The representation is representing something different from itself, and the relation of representation connects the representation to the object of representation (in general, it is the state of affairs in the world). These can be illustrated in the following graph:

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<sup>3</sup> The sign is usually picture as a running deer, rather than written words. It seems that natural signs cannot fail to represent, since the connection is a direct causal relation. Smoke signs fire, and this connection won’t fail under natural conditions.



In a very general way, this can be understood as the following: producer produces a token of representation, which carries some information about an object or its property (or in general, a state of affairs), and it is used by a consumer in the sense that this information plays a role in the consumer's behavior. This framework is quite general: a producer could be the nature itself (in such a case we have a natural sign); Producers and consumers could be different parts of the same organism, or the same organism in different place or time (for example, one marks a sign of danger on the road only for him to use when he travels back.); what is represented may be something internal to an organism (headache seems to be a representation of something wrong within my head.).

However, the model is pretty vague and cannot bring us too far without significant problems. First, there are disagreements among philosophers regarding what are counted as representations. For instance, some would treat natural signs as paradigm cases of representation while others would discount it as a case of representation. Yet this problem cannot be given an interesting answer without an understanding of the nature of representation. Answers to other aspects of representation will clarify our intuition about representations.

Second, what is the relation of representation? This seems to be the most intriguing question. In mathematical word, it is pretty straightforward to understand the relation of representation as a mapping or a function that maps a token of representation to a token of the represented. For example, upon hearing a person's production of a spoken token of 'Socrates', the relation of representation I have in my mind maps it to the ancient Greek philosopher who died from drinking hemlock. Yet the difficulty immediately emerges. The function is defined between a domain and a range. What is the domain of representations? In other words, what types the representation? Many people's pronunciations of the word 'Socrates' are dramatically different in many aspects, yet they are all well understood. So is with people's handwriting. It is a pretty complicated thing to teach computer to recognize handwriting (or speech patterns) even though people can do it very well without thinking. Clearly there are some invariant parts in all these tokens of representation, but what are they and why are only these parts kept invariant? Similarly, what is the range of the represented? More interesting, what is the logical relation between the domain of the representations and the range of the represented? Do we first have the range of the represented and the domain of the representations is defined from it, or is it the other way around? It seems that it is the natural properties that type things together, which are captured by representations, but the selection of natural properties (in the typing of representations) seems to be at least partially determined by organism's need.

It is not even clear what is represented. When human beings see a willow tree, intuitively we

represent it as a willow tree. But does the ant family that lives close to it also represent it as a willow tree? What about a bird who builds a nest in it? Think of a frog. He can catch a fly very well with his tongue. Yet unfortunately a frog's eyes cannot distinguish between a fly and a small moving object. (People can utilize this to catch frogs.) Does a frog represent a fly (or insects) as a small moving object or vice versa? The objects in the world have no names, no types in themselves, though there may be similar natural properties and correlations among them. It seems that if the relation of a representation is a mapping from a set (the domain: a type) to the other set (the range: another type), it cannot be fully understood without a prior understanding of its domain and the range.

Maybe this assumption is false. We may have a good understanding of the relation of representation before we have a clear understanding of its domain and the range. Even better, the clarification of the nature of the representation relation may help us determine both the domain and the range, and complete our picture of representation. This may turn out to be crucial to our understanding of representation. The typing problem is a crucial problem in metaphysics, but a stipulative answer will not do. And even if we get an answer to the typing problem, the relation of representation still needs an answer. On the other hand, it is more likely that a better understanding of representation can give us a clue to how objects are typed. So if we can clarify the nature of representation relation then we can have a theory of metaphysics.

How to understand the relation of representation? Different theories have proposed very different solutions. Before we introduce different theories of representation, here we want to outline some constraints for any acceptable theory of representation. First, there is a problem of under-determination. The relation of representation is a mapping from tokens of representation to tokens of objects, but it is not merely a mapping. In other words, not every mapping can be called representation. Clearly you can imagine any kind of mapping function, yet there is only one specific mapping that we are interested in, the one that actually exists between tokens of representation and tokens of objects. So any theory of representation that treats the relation of representation merely as a function (or isomorphism, or a causal chain that carries information) is not adequate. For example, in the case the simple marine bacteria, do they represent the direction of magnetic field, or do they represent the oxygen-free water, or both? The former is what its internal mechanism actually does, while the latter is what is important for its survival. Similarly, we can ask whether a sunflower represents the location of the sun or the source of light, or whether an odometer represents the distance traveled by the car or just revolutions of the wheels. Clearly a theory of representation should give us an answer to these questions.

The second problem is about misrepresentation. Misrepresentation happens in almost any representational systems. Any theory of representation then should be able to explain how misrepresentation is possible. It should be a theory that allows misrepresentation to happen occasionally, and indicates when and how it happens. The problem of misrepresentation is especially pertinent with our language system. The ability of misrepresentation (or thinking of intentional inexistence) seems to be a part of motivation for Brentano to mark mental affairs from other phenomena. The simple understanding of representation relation as a mapping cannot explain why misrepresentation happens. Actually it cannot distinguish a valid representation from a misrepresentation. A misrepresentation is also a mapping relation, and the key is which one of two mapping functions is the one we want to attribute as the relation of representation. Also there are so many mapping relations, and most of them do not represent anything. They do not

misrepresent either; they just do not represent.

This is connected with the problem of under-determination, since a misrepresentation can be a valid representation from a different perspective. In the case of marine bacteria, when there is a strong magnetic field at work (say you put a big magnet around these bacteria) they still represent the direction of magnetic field correctly, but not always the oxygen-free water. But the problem of misrepresentation is more complicated. Given good weather conditions, when a bee produces a dance pattern that indicates there are flowers in southwest where the flowers are actually in northwest, misrepresentation occurs. Something is wrong with the bee's internal mechanism that is responsible for production of bee dance. But what about a frog who mistakes B-Bs for insects? Does the frog misrepresent or not? Different theories differ on their answers.

The last issue, though not agreed by everyone, is the commitment to solving the problem of representation within a naturalistic framework. In other words, we should try to understand the phenomenon of representation in natural terms which are provided by sciences. This commitment is shared by most philosophers, though its particular interpretation does vary. In my understanding, this does not imply that the property of representation (or semantic properties in general) should be *reduced* to *physical properties*. Reductionism in this sense (that requires type-type identity) is too strong a claim and is probably false. It only requires an explanation of representation in a natural and non-circular way. This requirement excludes any explanation of representation in terms of the non-material soul or in terms of human intentionality (when it is not given a further explanation). It also excludes the approach that treats representation as a primitive concept that is taken as a given.

### **III. Theories of Representations**

Many philosophers are concerned primarily with a quite narrow field of representation, i.e. mental representation. The linguistic ability of human beings seems to be quite special and seems to require a special explanation. This approach is largely influenced by advancements in mathematical logic and the theory of computer science (e.g. the theory of Turing machine). As an analogy, the mind is understood as a supercomputer, and mental representations are proposition-like entities inside one's mind and can be formulated in logic languages. They are called the thoughts of language (Fodor). The advantage of this problem is that it immediately explains the combinatorial feature of language (one can form infinite sentences using a limited vocabulary), which is an amazing feature of mind. Chomsky, Fodor, and many AI researchers are committed to this view. Due to its clarity and formal presentation, this view has enjoyed strong support and has a large impact on the field and other related subjects. But it also faces serious challenges. First, there is serious doubt whether the human brain actually works like a Turing machine, even though it may have equivalent computational power to a Turing machine. The focus is about implementation of the mind: does the brain actually translate external information into internal language-like entities for further processing and control, as early AI research program tried to argue?

The model of connectionism, which is inspired by connectionist approach in AI research and proposed and defended by Churchland (cf. 1989) in philosophy, challenges just this point. But the connectionist model is very limited, and cannot explain the symbolic thinking characteristic of human reasoning. Their contribution is that the function of brain is not exhausted by language of thought approach to the mind. In other words, the mind is not merely a symbol-processor, but has different levels of processing that are quite independent. Robert Brooks' work on primitive but

self-sufficient robots provides empirical support that many complex behaviors can be explained without assuming symbolic processing at all (cf. Brooks, 1991). This could be the case with simple organisms like insects. Even in theory, the symbolic approach is too cumbersome and cannot do the job well given a limited resource. Both connectionism and Brooks's robotics claim to be non-representational but still account for what belongs to mental phenomena. Yet it seems obvious that there must be some internal configuration to be responsible for external behavior in simple organisms or in connectionist model. So we need to examine the notion of representation carefully before debating about what is representational or not. It is clear that symbolic representation does not exhaust the scope of representation. These questions immediately bring to the nature of representation, which should be answered by any general theory on representation.

Now more philosophers are committed to understand mental representation together with other kinds of representations. Many have argued that human being's cognitive ability is not dramatically different from other animals.<sup>4</sup> Rather there is a continuous line of development in organisms. Also evolutionary theory plays a larger and larger role in understanding and explaining the abilities of organism. Representations come in different grades. We may not need to postulate extraordinary qualities in human mind in order to understand human representations, at least a large part of the system.

Secondly, the language of thought model does not address the problem how representation comes about in the first place. It postulates internal mechanism in the head to explain our external linguistic behavior. Even if this could be done successfully, it does not tell us *why* the mechanism is there. In the case of representation, it may give us a precise of mapping from internal ideas to external objects, but it does not tell us why this mapping happens to come about. It is like dissecting a frog: you can see and record its structures very precisely but you may not have a clue about what these structures are for. This issue becomes important if we want to have a naturalistic understanding of representation. It may be exactly the historical traces of representations that determine the mapping. In other words, we cannot understand the relation of representation without relying upon the history of its occurrence. There are a lot of controversies on this issue. Still, logic-minded philosophers try to make a distinction between the way that a representation comes about and the representation itself. For example, the cargo and the train that carries the cargo are two very different things. Even though we can totally accept the evolutionary story of our brain, they claim that the evolutionary history does not give us an account of the representation itself.<sup>5</sup> This issue has some interesting implications, and is still actively debated.

In the following I will briefly present some theories of representation which are the most influential at the time, with a little bit of explanations and comments. There are more theories than what are discussed here. Even the theories that are discussed here cannot be given a complete picture and readers should consult the bibliography for further readings.

#### Cummins:<sup>6</sup>

Cummins is quite special in his insistence to reject any history-based account of representation. Cummins aims to provide an account of representation which is independent of its evolutionary history (how the representation comes about). In his words, "the attempt to

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<sup>4</sup> Andy Clark and Daniel Dennett, in a series of books and papers, have made quite convincing arguments and now this idea is quite popular among philosophers.

<sup>5</sup> For example, Smith (1996) and Cummins (1989, 1996) both hold this view.

<sup>6</sup> The discussion of Cummins' theory is based upon Cummins 1989, 1994, 1996.



understand mental representation in terms of adaptational roles also appears to reverse the explanatory order central to the CTC, and to be inconsistent with the thesis that cognition (and hence representation) supervenes on abstract formal structure that need not be historically specified.” (1994, p. 278)

Cummins’ alternative is to understand representation from functional role analysis. He labeled his theory as ‘Interpretational Semantics’. Cummins uses an example to illustrate. Consider the function of addition. How to explain it? Numbers are not physical states and so cannot be directly accessed by a physical system. The answer is to represent numbers with numerals, and an adding machine does just that. In an adding machine, the structure of it (the function  $g$ ) is isomorphic to the addition function (+). It is, “in short, simply the fact that  $g$  is isomorphic to + that makes the arguments and values of  $g$  representations of numbers for a system that satisfies  $g$ ” (ibid., p. 282). This means, representation is really nothing more than isomorphism. “It is sufficient for the arguments and values of  $g$ ’s being representations of addends and sums that there exist an interpretation mapping  $g$  onto +: the arguments and values of  $g$ ’s being representations of numbers is *constituted* by the fact that  $g$  instantiates +; representation is just a name for the relation induced by the interpretation mapping between the elements of  $g$  and the elements of +” (ibid.).

This is a very strong claim. Cummins also mentioned Galileo’s mathematic (linear) model of mechanic notion as an example. There are clearly many cases like this. We use pictures to represent many abstract relations to make us understand better. But under-determination is clearly a problem for this account. A bar picture may represent a particular population distribution, yet it may represent an income distribution of a company, or of a family, and many other things. An adding machine instantiates the function of addition, yet it may also instantiate the function of multiplication. Actually if a machine can only do addition, it is not exactly clear that its numerals represent numbers. This problem is more obvious with other kinds of representations. Does an odometer represent distance traveled or the revolutions of the wheels, or both? Does a rabbit recognize the eagle or the shadow cast by it? It seems that any isomorphic account cannot solve the problem of under-determination.

The other problem with this account is the issue of misrepresentation. In Cummins’ account, misrepresentation is not clearly marked from both representation and non-representation (failed representation). It is a matter of degree: “misrepresentation differs from failure to represent only in degree; failed representation becomes misrepresentation when the failure isn’t too bad” (ibid., 287). This explanation is very vague. Worse, it does not really address the problem of misrepresentation. For example, consider a bee is genetically malfunctioned and always produces the patterns of bee dance 180 degree reverse. There is still a perfect isomorphism between this bee’s internal structure and external world, but it is nonetheless a misrepresentation because it is different from the pattern that the other bees produce or that a bee is supposed to produce in the same situation.

Isomorphism may not even be a necessary condition for representation. What is important for representation is the mapping function, which is not necessarily isomorphic. It is not hard to imagine a case like this: your mind has a direct link between a rope and a snake, which does not exist in the actual world.<sup>7</sup>

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<sup>7</sup> This depends on how strict the requirement of isomorphism is. If isomorphism is given a loose understanding, it can be argued that any representation system is isomorphic to the world it is representing, at least when the system

Cummins' more recent approach is to try to distinguish between representations and targets (1996). Targets are what systems are intentionally directed towards; on the other hand, the representational contents are what a system represents those targets as being like (in his original understanding of representation). This distinction is used to solve the problem of misrepresentation. However this account goes beyond the original claim that representation is nothing more than isomorphism. Also the notion of target is not clearly spelled out, which weakens his project.

**Dretske:**

Dretske proposed an information-based theory of representation. Dretske defines representation as the following: "a system, S, represents a property, F, if and only if S has the function of indicating (providing information about) the F of a certain domain of objects."<sup>8</sup> This is further explained: "The way S performs its function (when it performs it) is by occupying different states  $s_1, s_2, \dots, s_n$  corresponding to the different determinate values  $f_1, f_2, \dots, f_n$ , of F" (ibid.). For example, a speedometer (S) represents the speed (F) of a car. "Its job, its function, is to indicate, provide information (to the driver) about, how fast the car is moving (F)" (ibid.).

Dretske's theory is a combination of teleological with information-theoretic ideas. It is clear that the representation carries information of what is represented. But this is not enough to account for representation. An extra concept "function" is introduced in this theory. The notion of function is of crucial importance to account for misrepresentation. Dretske admits that as a theory of representation, "it must be rich enough to allow for misrepresentation" (ibid., 4). The information-carrying function captures the normative aspect of representation – what a representation is supposed to (or should) represent, and thus Dretske's theory can account for possible misrepresentation when normal conditions are not obtained. An odometer is supposed to represent the distance traveled, in the sense that its proper function is to do so; but it can certainly fail to do so in a variety of ways.

Functional account is an important development to the theory of representation. It is to explain the phenomenon of representation in terms of functions. Function seems to be a more general notion than representations. Many things have functions but are not representations. For example, the heart has the function to pump the blood, and it does not represent the blood in any way. A screwdriver has function but is not representational in any normal sense.

The functional theory can be pretty general in the way as Wright (1973) understands it. However, recent discussions on functions focus on the teleological approach to function. This starts from Stampe (1977) and is followed by Dretske. Both Stampe and Dretske take representation essentially carry the information about the represented, and this informational relation plays a role in the system's evolutionary history and that is one of the reasons that the system survives. Given this functional analysis, a representational device represents an object when it is its function to do so. And misrepresentation, as Dretske points out, is very easy to be accounted for. A representational device has a misrepresentation if it represents an object different from the object that it is supposed to represent – i.e. the object that it is the system's function to represent.

This line of thought proves to be a very promising approach. Dretske distinguishes between conventional representation systems (in which he includes conventional signs, instruments, and

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functions normally.

<sup>8</sup> Dretske (1995), p. 2. The ideas presented here is a further development of Dretske (1986), (1988).

language – the last one is controversial), which derives their functions from human beings – we design or make their functions), and natural representational systems (in which he includes sensory and conceptual systems), which acquire their function naturally. Dretske's interest is to provide a naturalized account of human mind (including intentionality and consciousness as well as sensory abilities). However, there are few discussions on the nature of function itself. This is a weakness in Dretske's theory. Since the notion of function plays a very important (actually the foundational) role in Dretske's theory of representation, without a careful examination of the nature of function (esp. natural function), this theory is not complete. For example, we need to distinguish the proper function of a device from those functions that it just serves in a particular circumstance. When a hammer is used to strike nails into the wall it performs its proper function; it does not when it is used to kill a person. An egg performs its proper function when it is developed into a chicken but it does not when it was eaten by me. What is its proper function and how is it determined? It needs some further analysis.

There are quite a few challenges to Dretske's theory, which stem from the theory's requirement of a strict understanding of information links. The representation relation, as it is understood now, always (or almost always) connects the representation to the represented. This does not seem to be the case with many representations. The beaver's splash represents danger but most of the times it is just false alarm. Even with human language, many times the words do not refer and the sentences are not true. On the other hand, the natural connection between the representation and the represented is not really important to representation. There is a related problem to this: the problem of distal object. The natural causal connection connects the representation not only to the represented, but also to the causal links in between and beyond. For example, the marine bacteria's internal structure is linked both to the magnetic field and the oxygen-free water. Which one of these connections is the true representation relation we are looking for? Dretske struggled with this problem and did not give a satisfactory answer to it.

### Fodor:<sup>9</sup>

Jerry Fodor is an influential philosopher in philosophy of mind and philosophy of language. He once entertained a teleological theory of representation but gave it up immediately, and had become one of the most vocal critics of teleological theories.<sup>10</sup> The official theory of representation Fodor holds is his proposal of asymmetric dependence as a theory of representation, or in his word, a theory of content (meaning). Fodor's primary concern is with the problem of error, i.e. the problem of misrepresentation. The problem of error is similar to but narrower than the problem of disjunction that Fodor aims to solve. The problem of disjunction occurs when a theory of representation entails disjunctive contents that it should not. For example, if a theory cannot distinguish between a cow-caused 'cow' perception and a horse-caused 'cow' perception, then it faces the problem of disjunction since 'cow' now represents a disjunction of two things: horse or cow. Fodor's claim is that the disjunction problem is really about the difference between *meaning* and *information*. Information is tied to the causal process of the actual instantiation of a representation (e.g. a symbol). Information is there in the cases of misrepresentation. On the other hand, "*the meaning of a symbol is one of the things that all of its tokens have in common, however they may happen to be caused.*" Recognizing this distinction is the key to solve the error problem, according to Fodor. The idea is that a token of a symbol can be caused in many ways, yet they

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<sup>9</sup> The discussion here is based upon Fodor (1987, 1990a)

<sup>10</sup> Fodor was persuaded to publish his teleological theory of representation much later in (1990b).

only have one meaning. For example, ‘cow’ tokens can be caused in all sorts of ways, and they all mean *cow* for all of that. The meaning of a symbol is insensitive to variability in the causes of its tokening.

Fodor’s proposal relies on an asymmetric dependence he noticed between two kinds of uses of language. The idea is explained as the following: “Here is my first approximation to the proposal that I favor: cows cause “cow” tokens, and (let’s suppose) cats cause “cow” tokens. But “cow” means *cow* and not *cat* or *cow or cat* because *there being cat-caused “cow” tokens depends on there being cow-caused “cow” tokens, but not the other way around.* “Cow” means *cow* because, as I shall henceforth put it, non-cow-caused “cow” tokens are *asymmetrically dependent upon cow-caused “cow” tokens.* “Cow” means *cow* because *but that “cow” tokens carry information about cows, they wouldn’t carry information about anything*” (Fodor, 1990a).

Despite its apparent implausibility as a theory of representation, Fodor clarified and defended this proposal with very interesting explanations and arguments. I will neglect all the details and only comment on it a little bit. It is quite obvious that there is an asymmetric dependence relation between two kinds of uses of language tokens. If we do not know the meaning of *cow*, then we cannot misuse the term “cow” to falsely refer to a horse. Even in the situations that you can call a horse “cow”, falsely, it presupposes the meaning of “cow”. This seems right and is an interesting observation. But this does not actually tell us why “cow” means *cow*. In other words, Fodor does not give us further details of a theory of content, but at best some necessary conditions for a theory of content. He hasn’t touched the heart of the problem yet. Fodor intentionally avoids the above problems, because he wants a theory that “doesn’t assume that there are circumstances – nomologically possible and naturalistically and otherwise non-question-beggingly specifiable – in which it’s semantically necessary that only cows cause “cows.” (ibid.)” And his proposal satisfies this requirement since “all that’s required for “cow” to mean *cow*, according to the present account, is that some “cow” tokens should be caused by (more precisely, that they should carry information about) cows, and that non-cow-caused “cow” tokens should depend asymmetrically on these” (ibid.). But the problem is exactly with the first part, i.e. how some “cow” tokens are caused by cows. Fodor may think that this problem is a descriptive problem which has nothing to do with a theory of meaning, yet he seems to be mistaken. The historical trace of a symbol may turn out to be the only plausible way to provide the meaning of that symbol.

### Millikan:

Millikan’s theory is probably the most detailed account of representation based upon teleological approach. Like Dretske, Millikan’s theory aims to understand representation from the notion of functions, esp. natural functions. Millikan provides a very careful discussion on the idea of natural function, as well as a systematic account of different kinds of representations. This account is given a relatively detailed introduction in the following, partly due to its complexity.

The approach is quite revolved. A (direct) proper function is defined on a reproductively established family. Before we can define proper function, we need define the concept of reproductively established family. The notion of reproduction is defined as the following:

“An individual *B* is a “reproduction” of an individual *A* iff:

- ( 1 ) *B* has some determinate properties  $p_1, p_2, p_3, \text{ etc.}$ , in common with *A* and
- ( 2 ) That *A* and *B* have the properties  $p_1, p_2, p_3, \text{ etc.}$ , in common can be explained by a natural law or laws operative in situ, which laws satisfy (3) below.
- ( 3 ) For each property  $p_1, p_2, p_3, \text{ etc.}$ , the laws in situ that explain why *B* is like *A* in respect

to  $p$  are laws that correlate a specifiable range of determinates under a determinable under which  $p$  falls, such that whatever determinate characterizes  $A$  must also characterizes  $B$ , *the direction of causality being straight from A to B.*" (Millikan, 1984, p. 19-20)

The law in situ is intended to be causal laws. The idea of reproduction can be intuitively understood as "copy". Since under this definition, a paper copied via a copier is a reproduction of the original. When you learn handshaking from the observation of other people's handshaking, your handshaking is a reproduction of the other's handshaking. Linguistic items are often cases of reproduction. When a child learns to speak "cat" by copying his mother's use, his production of "cat" is a reproduction of his mother's production of "cat". Also a gene that is copied from parent's gene is a reproduction of it. My gene is a reproduction of my parent's genes. But my heart is not a reproduction of my parent's hearts, because even if my mother had a defective heart, I could have a good heart. Those properties of my mother's heart does not directly determine the properties of my heart (via some causal law), while some properties of my mother's gene does directly determine the properties of my gene (via some causal law).

The notion of first-order reproductively established family is now defined as:

"Any set of entities having the same or similar reproductively established characters derived by repetitive reproductions from the same character of the same model or models form a *first-order reproductively established family* (ibid., p. 23)."

Given the notion of first-order reproductively established family, the notion of proper function can be defined. However, Millikan defines a higher-order reproductively established family first using the notion of first-order reproductively established family:

" ( 1 ) Any set of similar items produced by members of the same reproductively established family, when it is a direct proper function of the family to produce such items and these are all produced in accordance with Normal explanations, form a *higher-order reproductively established family*.

( 2 ) Any set of similar items produced by the same device, when it was one of the proper functions of this device to make later items *match* earlier items, and these items are alike in accordance with a Normal explanation for performance of this function, form a *higher-order reproductively established family*.

( 3 ) If anything  $x$  ( $a$ ) has been produced by a device a direct proper function of which is to produce a member or members of a higher-order reproductively established family  $R$ , and ( $b$ ) is in some respects like Normal members of  $R$  because ( $c$ ) it has been produced in accordance with an explanation that approximates in some (undefined) degree to a Normal explanation for production of members of  $R$ , then  $x$  is a member of  $R$ ." (ibid., p. 24-5)

This is a recursive definition. It utilizes the notion of "proper function" and the notion of "Normal explanation" that are defined on the notion of "reproductively established family," which includes both higher-order and first-order reproductively established families. Given this definition, my heart and my parents' hearts (similarly with other human organs), form a higher-order reproductively established family, since they are produced by members of a first-order reproductively established family – my genes and my parents' genes, and it is their proper function to do so in accordance with Normal conditions. All Buick Regal assembled in a factory (a production line) form a higher-order reproductively established family, since they are all produced by the same device, and one of the device's proper functions is to make sure all cars are the same, in accordance with the design. Condition ( $c$ ) is a weakening of the first two conditions in

order to make room for malfunctioned members of a family. Given this condition, a malfunctioned heart is still a member of the higher-order reproductively established family.

Now the idea of proper function can be spelled out. Intuitively, an individual  $x$  has  $F$  as a proper function if the performance of  $F$  helps  $x$  survive somehow; or more precisely, an individual with character  $C$  has  $F$  as a proper function if by having  $C$  the individual  $x$  gains a survival advantage and by having  $C$  it *can* perform  $F$  (note this does not imply that by having  $C$   $x$  always perform  $F$ ; the distinction is of some interest in later discussions). In other words, there is a (statistical) positive correlation between individuals having  $C$  and the performance of  $F$ , in the sense that the performance of  $F$  helps the individuals having  $C$  proliferate. Millikan gives the following definition:

“Where  $m$  is a member of a reproductively established family  $R$ , and  $R$  has the reproductively established or Normal character  $C$ ,  $m$  has the function  $F$  as a direct proper function iff:

( 1 ) Certain ancestors of  $m$  performed  $F$ .

( 2 ) In part because there existed a direct causal connection between having the character  $C$  and performance of the function  $F$  in the case of these ancestors of  $m$ ,  $C$  correlated positively with  $F$  over a certain set of items  $S$  which include these ancestors and other things not having  $C$ .

( 3 ) One among the legitimate explanations that can be given of the fact that  $m$  exists makes reference to the fact that  $C$  correlated positively with  $F$  over  $S$ , either directly causing reproduction of  $m$  or explaining why  $R$  was proliferated and hence why  $m$  exists.” (ibid.)

An ancestor of an item is a member of a reproductively family from which the item is derived from successive reproductions (in the first-order families), or a temporarily earlier member produced by the same device which produces the item or an earlier member produced by an early ancestor of the device that produces the current item. The idea to introduce character  $C$  is that in quite a few situations, the proper function of a device is rarely fulfilled. For example, there are only a few sperms that actually serve its proper function. Or a beggar may say a specific phrase to beg for money and out of 20 times he only gets it once. But as long as that pattern of begging works better than other available patterns or not asking at all, i.e. it achieve the function of getting money better, this particular phrase correlates positively with the proper function of getting money. And this correlation between the phrase and the function is one necessary component of a legitimate explanation to why this phrase is still used by beggars.

Clearly a device can have many proper functions. We are often only interested in the *focused* proper function, which is the last proper function without divergence. For example, the heart has proper function to pump the blood, which keeps the brain active, which further makes one be able to speak, etc. Yet the focused proper function of the heart is to pump the blood, since after this step, the functions diverge. Many other things depend on the proper pumping of the heart (not only brain depends on it, but also kidney, lung, and running need it), and there is no systematic way to sort thing out there.

Another important concept is the *derived proper function* (contrasted with *direct* proper function – often abbreviated as proper function). This starts with relational proper functions, which bears a specific relation to something else (in the environment). In other words, a relational proper function is not fully determined but depends upon external variables. For example, a pattern of a bee dance does not by itself tell the direction of nectar; it also needs the location of the sun at the time of dancing and the location of the bee. Relational proper functions are direct proper

functions. However, we can *derive* a derived proper function from relational proper function. Derived proper function is not a direct proper function. It is not based upon a reproductively established family. Instead, it is a function of the adapted device (a device produced by a relational proper function together with variables in the environment). In other words, it is derived from the relational proper function by filling in the values of variable (given a particular situation). For example, a bee dance may only occur once in a lifetime. This particular pattern has a derived proper function to lead the bees to the southeast, for example.

Now we have the needed tools to deal with representation. Millikan first tries to define “Intentional Icon” as a sentence that satisfies the following conditions (4(a) and 4(b) are disjunctive; one of them needs to be satisfied):

“ ( 1 ) A sentence is a member of a reproductively family having direct proper functions.

( 2 ) Normally a sentence stands midway between two cooperating devices, a producer device and an interpreter device, which are designed or standardized to fit one another, the presence and cooperation of each being a Normal condition for the proper performance of the other.

( 3 ) Normally the sentence serves to adapt the cooperating interpreter device to condition such that proper functions of that device can be performed under those conditions.

(4a) In the case of imperative sentences, it is a proper function of the interpreter device, as adapted by the sentence, to produce conditions onto which the sentence will map in accordance with a specific mapping function.

(4b) In the case of indicative sentences, the Normal explanation of how the sentence adapts the interpreter device such that it can perform its proper functions makes reference to the fact that the sentence maps conditions in the world in accordance with a specific mapping function.” (ibid., p. 96-7; some details omitted)

“Sentences” here is understood broadly. In the above sense, bee dances are intentional icons, and so are linguistic items.<sup>11</sup> Yet linguistic items are different intentional icons from bee dances. Actually, intentional icons are very primitive representations, if they can be called representation at all. According to Millikan, full-fledged “representations are intentional icons the mapping values of the referents of elements of which are supposed to be identified by the cooperating interpreter.” In this sense, bee-dances are not representations, since an interpreting bee does not actually *identify* (understand the reference of) the mapping aspects of the dance – it just reacts to the intentional icon. *Identification* of the *referent* is a very complicated matter, which needs a separate analysis. Broadly, bee-dances can be said to be *primitive* representations. Actually, a bee dance is both indicative (the place of nectar) and imperative (ordering the observing bees to fly there) in the above definition.

Under this understanding, we can see that intentional icons map to their real mapping value when they *function* properly. This gives us a clear picture of what a representational device essentially is. Intentional icons are paradigms of signs. Other kinds of representation can be classified in this framework. Consider a stop sign. It is a very simple sign. Is it an intentional icon? It satisfies the first condition, since it is a member of reproductively established family. It also satisfies the second condition, since it stands between a producer and a consumer which are designed to fit each other, and the presence and cooperation of each being a Normal condition for

<sup>11</sup> Millikan here has a detailed and interesting discussion on the “meaning” of a sentence. The idea of “Fregean Sense” as a mapping relation is introduced as the “meaning”.

the proper performance of the other (imagine the stop sign is put in a wrong place). It satisfies condition (3), though in a very simple way. A stop sign, though not different from other stop signs in shape, is individualized in a particular way – by its location. This variation adapts the consumer to a condition (avoiding traffic accident) that the consumer's proper function can be performed, i.e. drive safely, etc. It also satisfies condition (4a). The derived (adapted) proper function of a stop sign asks the consumer to stop at that particular place, in imperative sense. Similarly, the flowing of adrenalin in one's body *at a particular time* is also an intentional icon that has a (adapted) proper function to ready the organism for the present danger *at the time*.

Millikan argues that without a potential interpreter (consumer) there is no representation, no sign, nor intentional icon. For example, the chameleon's color pattern, though it maps to a real value, is not a sign since it does not have nor need any interpreter. Natural signs are called signs, though in a strict sense they are not intentional icons. This is because natural signs are not members of reproductively established family and do not have direct nor derived proper function. But natural signs are analogous to intentional icons in an important way: they can be used by interpreters and adapt interpreters in a particular way. Smoke indicates fire and we certainly utilize that connection. There is another difference between natural signs and intentional icons. The relation of representation in the case of natural signs is statistically reliable (most of the time it is true when there is smoke there is fire), while the relation of representation in the case of intentional icons is based upon the icons' evolutionary history.

Another important kind of representations is improvised signs. Suppose one day that I leave work early and go home to cook for my wife. I leave the door open to indicate to my wife that I am already home. The open door is an improvised sign, because I assume that she knows that the door is opened by me and she then knows I am already home, and she knows that I knows that she knows this, etc. These are also similar to intentional icons in some way. They do not belong to any reproductively established family, but they do have a derived proper function – derived from the intention of their producer, that adapts the interpreter in a particular way. Intentions or purposes are more general mechanism that works wonder for human beings, yet that is a separate issue from representation.

Representation of instruments can be intentional icons. Many instruments are designed by copying the previous patterns of same kind of instruments. For example, odometers in cars are often copied from its previous models. In this sense they form a (higher-order) reproductively established family. Even though instruments do not belong to a reproductively established family, it is very similar to a reproductively established family. Instruments are made according to a standard need of human beings. They have a derived proper function, derived from human intention. For example, different makers of cars may have quite different designs for their odometers, yet they need to make sure that an adult human being can easily read these odometer. This intention makes sure that all odometers are very close to a reproductively established family.

Representations come in degrees. Millikan's theory can provide a pretty unified account of various kinds of representation, and this is an important characteristic to it. But there are also serious challenges to this theory. One such problem for the theory is the problem of "swampman", an imaginary case first given by Davidson (1980). Suppose in a swamp lightning striking a tree near a swamp you are standing beside, and it destroys you but at the same time creates an exact molecule to molecule copy of you at the same place. A swampman is created totally by coincidence and has no causal connection to you in any sense. So the swampman has no



evolutionary history, and should have no representations (beliefs, desires) at all if these concepts are defined from teleological terms. However, the swampman behaves just as you do, and intuitively seems to be able to have beliefs and desires as you do. This seems to indicate that there must be something wrong with teleological theories of representation. There are some replies to this problem but none of them is completely satisfactory.

#### **IV. Impacts**

Theories of representation have a large impact on other fields, especially philosophy of language, philosophy of mind, and artificial intelligence. Millikan provides a detailed account of meaning which distinguishes three kinds of meaning: 1) the stabilizing and standardizing function of an intentional icon; 2) Fregean sense—the mapping function of an intentional icon in accordance with which it is supposed to map onto a real value; 3) intension – the third aspect of meaning. In my opinion, this theory provides the most comprehensive and successful explanation for linguistic phenomena. It does have some challenges, but the project is the most promising one.

In philosophy of mind, representationalism (a claim that mental are representational) seems to be the framework of current debates in this field. A careful clarification of representation should clarify a lot of issues here. Similarly a lot of conceptual issues can be better clarified with a better understanding of representations.

In conclusion, philosophers have reached a lot of agreements on the theory of representation. Though there are still serious debates, we can be optimistic about the future.

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## 表征理论

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**摘要：**表征理论是近期西方分析哲学研究的一个核心领域，并对相关学科有着相当大的影响。已经有不少的理论被提出来，但目前仍没有一个为大家都能接受的理论。本文试图综述当前最有影响的几个表征理论，并给出一定的历史背景和个人评论。

**关键词：**表征理论；意向性