Simplicity and Elegance in Millikan's Account of Productivity: Reply to Martinez*

Brian Leahy
Department of Linguistics, University of Konstanz

1 Introduction

The problem of productivity asks us to explain how novel sentences, or novel representations in general, can have determinate semantic content. Ruth Millikan (1984, 2004, 2013) offers a response to this problem in terms of rule following and mapping functions. This paper addresses two challenges to Millikan's account of productivity: the "Kripkenstein" challenge raised in (Kripke 1982) and an objection raised in (Martinez 2013). I will discuss Millikan's answers to both challenges, and will identify a conflict between these answers. Finally, I will offer a modified version of Millikan's account of productivity that resolves the conflict while preserving the essential features of Millikan's theory.

The paper is structured as follows. Section 2 presents Millikan's theory of intentionality and productivity. Section 3 describes the two challenges. Section 3.1 describes Kripke's challenge and Millikan's reply. Section 3.2.1 describes Martinez' challenge and discusses its logical relationship with Kripke's challenge. Section 3.2.2 makes explicit how Millikan's reply to Kripke appears to work against Martinez' logically weaker challenge. We then notice (section 3.2.3) inadequacies in Millikan's response to Kripke, and demonstrate (section 3.2.4) that those inadequacies can be remedied, leaving us with a complete response to both Martinez and Kripke. Section 4 concludes.

2 Millikan on Intentionality and Productivity

* Manolo Martinez, Ruth Millikan, and Miljana Milojevic discussed this paper with me at length, and I thank them for the many resulting improvements. I especially wish to thank the editors and reviewers for Philosophical Psychology for thoughtful and patient comments that have helped me produce a much stronger paper.

In this section I lay out Millikan's theory of intentionality step by step, building up the tools we need to see how that theory mandates her account of productivity. I will use multiple examples to illustrate different components of Millikan's theoretical apparatus.[1]

The fundamental notion in Millikan's theory of intentionality is "proper function". To specify the proper function of an object is to say what it is supposed to do or what it is supposed to be used for. "Supposed" is analyzed in biological, historical terms. Very roughly, an individual i has proper function F if i is a descendant of an individual i' that was selected for doing F. 'Descendent' must be understood broadly to include not only biological descendants but also many other kinds of reproductions. To illustrate, the lenses of my eyes have as function to focus light reflected from objects in the environment onto my retina. The lenses of our eyes are descendants of earlier lenses that in fact focused reflected light onto retinas, and the fact that they did so caused their selection for. That is, because they focused light so well, lenses like ours contributed more to the fitness of individuals with those lenses than alternative lenses contributed to fitness of individuals with alternative lenses. Lenses like ours proliferated amongst humans: they were selected for. Consequently, focusing light in that manner is a proper function of our lenses.

Every proper function is associated with a *normal mechanism*: that is, the causal mechanism by which effects were most often generated, thereby establishing those effects as functions (Millikan 2004, ch. 5). Thus normal mechanisms are mechanism types, abstractions over the token causal mechanisms that were in place on occasions of function performance. *Normal explanations* are descriptions of normal mechanisms (Millikan 2013). Normal

---

[1] A fully detailed discussion of the relationship between Millikan's theory of intentionality and productivity appears in (Leahy 2014), and the cardinal statement of the view is in (Millikan 1984). The current discussion makes many space-saving simplifications.

explanations are type level explanations, descriptions of causal mechanism types. If a device i with function F is a member of a reproducing family I, a normal explanation for how members of I perform F describes internal features that members of I always had on the relevant occasions, environmental conditions that members of I were always in on the relevant occasions, and shows how this arrangement guarantees, together with the laws of nature, the performance of the function (Millikan 1984:33-34). For example, the normal explanation for the performance of the lens' light focusing function will appeal to features of lenses such as shape, transparency, and so on; to environmental features such as the diffractive properties of air, the available light and surface reflectance properties of earthly objects, etc.; and to whatever natural laws are required to show how this arrangement leads to the focusing of reflected light on the retina.

Two comments are in order. First, we should clarify which occasions are the "relevant occasions" referred to in the last paragraph. Functions are sometimes performed by accident: rabbits' foot-thumping mechanisms have as function to cause conspecifics to avoid danger, and this normally happens when rabbits perceive predators, which causes thumping. But rabbits are skittish; sometimes they thump in response to falling branches. Usually such thumps fail to perform their function. But sometimes rabbits thump in response to falling branches when there are unperceived predators nearby. Here the function of causing conspecifics to avoid danger will be accomplished, though by accident. The function, in this case, is not performed via the normal mechanism. Such accidental function performances must be excluded from the set of relevant occasions. This is why the qualifier *most often* appears in the characterization of normal mechanisms.

This fact may sometimes introduce complications for researchers trying to describe normal mechanisms, that is, trying to produce normal explanations. This brings us to the second comment. Since normal explanations describe mechanism types, they always involve a generalization. They describe the mechanism that was operative in the largest class of cases where the function was performed by a common mechanism (and not, as described in the last paragraph, by accident). This introduces challenges for the describer: how do we establish when two instances of the performance of a function are instantiations of the same mechanism type, since (from the last paragraph) we know that some functions are actually performed by multiple mechanisms? Sometimes the answer to this question will be clear from the empirical data, but other times it may not. There may be multiple competing theories about the normal mechanism for the performance of some function, and these theories are to be evaluated on the basis of their scientific merits. For example, a theory that covered a larger class of cases by disjunctively describing several mechanisms may be rejected in favour of a theory that covers a smaller class of cases in a more unified manner. On the other hand, sometimes disjunctively describing several mechanisms will reveal otherwise unseen relationships or broaden the scope of the generalization so as to make the disjunctive explanation superior to available nondisjunctive alternatives. Considerations of simplicity, elegance, and empirical coverage can help us determine the correct normal explanation, that is, the correct description of the causal mechanism-type that has been selected for.

A few terminological comments. A *most proximate* normal explanation for a function F is a least detailed description of a normal mechanism that still fully describes how F is most often accomplished when it is accomplished. When a member i of family I accomplishes a function F by the mechanism described in the most proximate normal explanation, we will say that it has functioned *normally*. When i has the internal structures described by the most proximate normal explanation, we will say that i is *normally constructed*, and when i is in the environmental conditions described by the most proximate normal explanation we will say that i is in its *normal conditions*. I also distinguish the *internal contribution* to the normal mechanism from the *environmental contribution* to the normal mechanism. When an individual's function fails to be performed, it is either because the individual failed to do its part, or because the environment failed to cooperate, or both. That is, either the internal contribution isn't made, or the environmental contribution isn't made, or both.

Having described normal explanations in detail, we now describe a special kind of proper function that is involved in evolved signalling systems. Sometimes some devices can perform some function better if they are causally sensitive to variations in some environmental condition. For example, honeybee foraging mechanisms have as function to bring nectar to the hive. But blind foraging is inefficient; bees forage more efficiently if they are causally sensitive to locations of nectar before they leave the hive, so that they can go directly to a nectar source instead of wasting resources foraging blindly. Honeybee dances have evolved to provide that causal sensitivity. Successful foragers return to the hive and perform a dance that varies in two parameters: its orientation on the honeycomb and the duration of its waggle section. The orientation of the dance corresponds to the direction of the nectar found, as follows. If the orientation is vertical and upwards, observers leave the hive and fly directly toward the sun. If the orientation is vertical and downwards, observers leave the hive and fly directly away from the sun. If the orientation is 47° to the right of the vertical oriented upwards, observers leave the hive and fly 47° to the right of the sun, and so on. The duration of the waggle section corresponds to the distance of the nectar found as follows. Temporally longer waggle sections cause observing bees to fly longer distances (adding 0.1 seconds to the dance yields about 100 extra meters flight). These dances cause observing bees to return to the source of nectar found.[i]

When we examine instances of successful nectar collecting, we see that we can't fully describe how nectar most often gets collected without describing bee dances. So these dances are part of the most proximal normal explanation for this function. Moreover, dances take different forms on different occasions, and nectar was found in different locations on different occasions. Hence there are differences in the causal mechanism by which nectar gets collected on different occasions. Now, when we first discussed normal explanations, we noted that theorists may face difficulties in establishing the correct normal explanation, which are type level explanations that must be generalized from tokens. And there is an important respect here in which the tokens are tokens of *different* types, exactly because dances take different forms on different occasions and nectar was found in different locations on different occasions. But we can subsume these different tokens under a single type-level explanation if we can establish a plausible *mapping function* (here 'function' in the mathematical sense) that shows how variations in the form of the dance covary with variations in the location of nectar on different occasions and hence with variations in where observing bees are to go. So we can see that these different mechanisms are really instances of the same mechanism—variations on a common theme—when described at a suitable level of abstraction. Considerations of simplicity, elegance, and empirical coverage will help us find the right level of abstraction, as well as help us choose amongst competitors at a single level of abstraction. Millikan's response to Kripke, described in section 3, shows how considerations of theoretical virtues help us choose amongst competitors at a single level of abstraction. We will not illustrate how theoretical virtues help us find the right level of abstraction, since those issues are tangential to this paper.

Note that bee dances covary with both (a) how observing bees should respond to the dance, and (b) locations where nectar is.[ii] Thus this signalling system has both descriptive and directive aspects; it is what Millikan calls a “pushmi-pullyu” signalling system (Millikan 1995). From a pushmi-pullyu mapping function we can always generate a unique rule that describes how observers should respond to signs. In the following I will sometimes conflate pushmi-pullyu mapping functions with the unique rules for behavior derived from those mapping functions. This will simplify my prose and keep my terminology in line with Martinez’. I presume no confusion will arise.

We might state Millikan’s view more generally. Suppose that there is a family of devices with some proper function F. Suppose members of this family can do F better when they can adjust their behavior to match variations in some environmental condition E. (Call this family I, because its members will turn out to be sign *interpreters.*) Suppose there is another family of devices (call them P, because they will turn out to be sign *producers*) that also benefits when members of I do F. Now, suppose that members of I can’t tell what state E is in on their own, but members of P can. Suppose that members of P (producers) are causally connected to members of I (interpreters) by some medium M, and that producers can manipulate the state of M and hence manipulate the behavior of interpreters. Suppose that these manipulations yield differences in how interpreters behave in trying to perform F. Bear in mind that if producers manipulate interpreter behavior in a manner that harms interpreters, then alternative interpreters that are disposed to respond to those manipulations in less harmful ways will be selected for over individuals that respond in ways that harm themselves. On the other hand, if producers manipulate interpreter behavior in a manner that helps interpreters, then alternative interpreters that are disposed to respond to those manipulations in less helpful ways will be selected against.

Now, remember that the best way for an interpreter to get F done depends on E, and that producers are causally sensitive to the state of E. Moreover, producers benefit when interpreters perform F. One way that interpreters might manipulate interpreter behavior is to systematically adjust interpreter behavior to make F more likely given the state of E. Such a system would have the benefit of being mutually advantageous for interpreters (who perform F more) and for producers (because interpreters perform F more). If producers and interpreters arise with those dispositions, they will likely be selected for over alternatives whose dispositions do not confer these benefits (all else equal). When such a system of producer manipulations and interpreter responses has been selected for, we have a (pushmi-pullyu) *signalling system*, and the various possible forms of M are what Millikan calls *intentional icons*. We will call them *icons* or *signs*. If we want to fully describe the resulting mechanism by which interpreters most often get F done when they get F done, that is, if we want to provide a normal explanation for the performance of this function, we will have to describe how producers systematically modify interpreter behavior in a manner that matches the form of E. The description will have to show how variations in M correspond to variations in E and to variations in how consumers should respond. This is to describe a *mapping function*.

We noted above that there may be competing normal explanations for the performance of some function in the sense that different theories may provide incompatible descriptions of the mechanism by which F is normally performed. I chose to lay out the theory as I have here in part to illustrate that *sometimes* the best candidate normal explanation is one that appeals to a mapping function, that is, a mathematical function that shows how modulations of a medium (for example, the bee dance) covary with variations in the form of some variable range of environmental conditions (with locations of nectar) and/or with how observers should respond to signs (with where observers should fly). On Millikan's view, we have a signalling system only if the normal explanation for the performance of interpreter functions in response to icons appeals to a mapping function.

Mapping functions describe the interpretations of signs. In the pushmi-pullyu case they describe how signs should covary with variations in environmental variables and how interpreter responses should covary with variations in signs. The meaning of a descriptive sign S is the state of that environmental variable that S maps to according to the mapping function. The meaning of a directive sign is the response that interpreters should make to that sign, according to the mapping function. The meaning of a pushmi-pullyu sign is the meanings of the directive and descriptive signs at once.

Now, all possible bee dance orientations are mapped to a direction, even if there happens to be some orientation that has never been danced before (say, 67°). Any future dances with 67° orientation will nonetheless have an interpretation, as described by the mapping function. Also, there may be combinations of values that have never been danced together before (for example, a dance with orientation 34° to the right of the vertical with waggle section duration 2.4 seconds); any future dance with this novel combination of values still has an interpretation, as described by the mapping function (Shea 2013). Thus mapping functions can address the problem of productivity: they explain the interpretability of novel signs.

Note that mapping functions *describe* the interpretations of signs. Mapping functions are constructed by scientists trying to describe the mechanism by which some function is most often performed. Mapping functions do not *determine* the interpretations of novel signs. The interpretation of a novel sign is determined by the causal system that was selected for in the history of the signalling system, by the system of dispositions that sign interpreters are “supposed to” have, because they were “designed” by evolution to have those dispositions (Millikan 2013). We will return to this point in section 3.2.2.

3 Two Objections to Millikan’s Theory

In this section we present Kripke’s challenge regarding rule following and Millikan’s response to Kripke; then we see Martinez’s challenge and the respects in which it is logically weaker than Kripke’s. Thus the falsity of Kripke’s conclusion is not logically sufficient for the falsity of Martinez’ conclusion. We then see how Millikan’s response to Kripke in fact provides a satisfactory response to Martinez. Then we consider a strengthening of Martinez’ worry that demonstrates a need to modify Millikan’s position, and provide the required modifications.

3.1 Kripkean Scepticism and Millikan’s Reply

3.1.1 Kripkean scepticism

To understand the meaning of a sign requires being correctly guided by the mapping function for the signalling system it belongs to in responding to the sign. To be guided by a mapping function in responding to a sign is to be guided by a rule. Kripke (1982) raises a challenge for claims about rule guided behaviour. Since on Millikan’s account one understands the meaning of a sign only if there is such a thing as following a rule, she must ensure that Kripke’s challenge does not undermine her theory of meaning.

Kripke illustrates his challenge with the example of addition. Addition is a definable mathematical operation. But there are many definable mathematical operations that yield the same results as does addition for all pairs of numbers that are ever added by humans, but that yield different results for pairs of numbers never added by humans. Pretending that no human has ever added a number greater than 56, one such operation is the *quus* operation: quus yields the sum for every pair of numbers that includes no number greater than 56, and 5 for every pair that includes a number greater than 56. Kripke's sceptic (Kripkenstein) challenges us to say what makes it the case, should we be asked to add 57 and 68, that the correct answer would be 125 and not 5. Our past behaviour on past occasions does not determine what we meant by 'plus' on earlier occasions, since all past behaviour conforms to the addition rule, the quaddition rule, and many other rules. What makes it the case that we meant addition and not quaddition, that one of these rules was being followed and not the others?

Some responses to the sceptic are ruled out. First, the problem is not resolved by appealing to an internal representation of the addition function that determines that you mean addition rather than quaddition. Appeal to internal representations cannot solve the general problem of what it is to follow a rule. For we will then need to interpret those internal representations; we need criteria that determine when the internal representation of the addition function is correctly applied—that is, criteria that tell us whether we mean addition or something else by 'plus'. But this is another instance of the problem we started with. Pursuing this line threatens regress.

Second, we cannot maintain that meaning addition rather than some alternative consists in being disposed to follow the addition rule rather than some alternative. Three problems arise. First, our actual dispositions in adding include dispositions to make mistakes, and so our actual dispositions are better described by some quuslike rule than they are by the rule for addition. Second, addition is defined for all natural numbers, which includes numbers that are simply too big for us to comprehend and so too big for us to have any dispositions to add. Third, rules are normative: they can be correctly or incorrectly applied; they can be followed and they can be broken. A dispositional view equates actual performance—or actual dispositions to perform—

with correct performance. This eliminates the possibility of incorrect application of a rule, of breaking the rule.

3.1.2 Millikan's response

Millikan responds to Kripkenstein's challenge by distinguishing intentional rule following from being competent to follow a rule. These competencies are not represented and so do not require interpretation, so they can block the threat of regress. Being competent to follow a rule is just having conforming to that rule as a function: that is, there are historical instances of conformation, and there is increase in the distribution of traits that enable conformation that cannot be fully explained without appeal to the fact that those traits enable conformation. Now the sceptic wonders: but of course, all those historical instances of conformation were instances of conformation with indefinitely many rules. How are we to privilege one of these? Millikan's answer: every function is accompanied by a normal explanation, and choosing the best normal explanation requires that we evaluate the simplicity and elegance of competitors. Suppose, for example, that no bee has ever found nectar in a direction between 42° and 45° right of the line from the hive entrance to the sun, and that no bee has ever performed a dance with orientation between 42° and 45° right of the vertical axis of the hive oriented upwards. Then all historically normal instances of interpreter behavior in response to dances conform to the requirements imposed by the standard and by the quuslike mapping function (restricting attention, here, to the orientation/direction parameter and the directive portion of the sign):

> **Standard mapping function** requires that if the dance is x° off the vertical, interpreters should travel in a direction x° off the line from the hive entrance to the sun.
>
> **Quuslike mapping function** requires that if the dance is x° off the vertical and x is not between 42° and 45°, interpreters should travel in a direction x° off the line from the hive entrance to the sun; otherwise, they should rest at ease.

Should the normal explanation for the interpreter's nectar collecting function appeal to the quuslike mapping function or to the standard mapping function? Millikan writes, "I don't have any particular theory of explanation up my sleeve. But surely, on any reasonable account, a complexity that can simply be dropped from the explanans without affecting the tightness of the relation of explanans to explanandum is not a *functioning* part of the explanation" (1990:334, emphasis original). Such a nonfunctioning component of an explanation is reasonably eliminated for complicating the explanation without benefit. Given that two competing explanations have equal explanatory power, the simpler explanation is better. Simplicity, in this case, is measured by the "dropability" of clauses. In this case the "droppable" clauses in the standard mapping function form a proper subset of the "droppable" clauses in the quuslike mapping function, and so the normal explanation that appeals to the standard mapping function is preferable to the normal explanation that appeals to the quuslike mapping function. The quuslike mapping function complicates the explanation but yields no increase in explanatory power.

Millikan then distinguishes having as function to follow a rule from being disposed to follow a rule. It may very well be that, due to engineering constraints faced in the evolution of the system, bees are usually quite disposed to rest at east in response to dances between 42° and 45° off the vertical. Then the quuslike bee dance rule describes actual bee dispositions better than the standard explanation does. Millikan notes, though, that by hypothesis this disposition didn't help in the proliferation of bees with that disposition (since it was never activated). So the normal explanation for the performance of the function should not employ the quuslike mapping function, which still involves an extra complication with no increase in explanatory power. This separation of functions from dispositions enables Millikan to capture the normativity of rules.

There is such a thing as incorrectly applying a rule, as breaking a rule. Rule breaking is malfunctioning.

3.2 Martinez' Worry and a Millikanian Response

3.2.1 Martinez' worry

In this section I describe Martinez' concern and show that it is a logically weaker worry than Kripke's. Martinez and Kripke both raise sceptical challenges for rule following; Martinez' challenge is logically weaker than Kripke's in that it raises the same challenge over a more limited domain. Thus Martinez' argument is stronger than Kripke's in the sense that it is more difficult to refute.

On Millikan's account, when an icon is true and produced in accord with a normal explanation, it is a natural sign of the state of affairs it maps. Martinez notes, though, that natural sign relations typically hold only within some restricted domain. For example, the number of apples laying on the ground in a certain field in the fall may be a natural sign of the strength of the wind that has recently blown past the tree, but only for winds with certain causal properties: if the strength of the wind is too low, then no apples will fall, and so there will be no natural signs that distinguish between the strengths of slight breezes. If the strength of the wind is too high, then all the apples will fall; again, there will be no distinction between the various strengths of wind that are above this threshold. The natural sign relation holds only between these upper and lower bounds; the region between these boundaries he calls the *causally grounded domain* of the natural sign relation. Martinez agrees that Millikan provides a mechanism that adequately determines the interpretation of (i.e., the correct, rule bound response to) novel icons within the causally grounded domain such that, when the icon is true and produced in accord with a normal explanation, it is a natural sign of the state of affairs it maps. Thus he accepts Millikan's response to Kripkenstein regarding what counts as following a rule inside the causally grounded domain. However, icons may be produced outside these domains; Martinez' concern is with what determines the correct mapping rule for the interpretation of an icon outside of its causally grounded domain.

Two of Martinez' examples serve to clarify the objection (one is slightly modified here). In a rabbit's natural environment, fox fur is a recurring natural sign of foxes. This recurring natural sign relation is part of what has enabled the development of the rabbit's foot thump signalling system that warns conspecifics of danger nearby. Rabbits that thumped in response to observations of fox fur and had conspecifics that took predator avoiding actions in response to thumps were more successful than those that did not. As a result, when a rabbit thump is true and produced in accord with a normal explanation, it is a natural sign of danger nearby. But what if we take a rabbit out of the domain where fox fur is a recurring natural sign of foxes? For example, what if we take a rabbit to a lab where there are many fox furs that have, so to speak, no foxes inside of them? Here we are outside of the causally grounded domain where rabbit thumps are natural signs of foxes. What determines which mapping rule is the right one for rabbits to follow in this lab, outside the causally grounded domain for the system of natural signs?

Another of Martinez' examples is a bee dance with a waggle section duration one hundred thousand times as long as a waggle run that indicates that there is nectar 50 meters from the hive. He thinks this dance does not indicate a location of nectar 5000 kilometres from the hive; we are "forced to say that [this dance] is meaningless: the causal grounds that cover the relation of typical dances to positions of nectar do not cover [this dance] and, thus, there is no fact of the matter regarding which mapping function we should apply to it" (p. 59).

The argument continues. Martinez distinguishes two varieties of productivity, which he calls *indexical* and *compositional* productivity. Some signalling systems display only indexical productivity: the variable elements of icons are only the time and place of icon production, and those covary with the time and place of the state of affairs signified. The rabbit's foot thump is an example: producers manipulate the time and place at which foot thumps are heard, and these should correspond to variations in the time and place at which there are predators nearby, but there are no other variable aspects of the sign.

Signalling systems with compositional productivity contain nonindexical variable elements. Martinez writes, "A thought system is productive in this other sense, roughly, if it counts with a vocabulary of concepts and of modes of composition, such that the content of a thought is determined by the content of the concepts that compose it and the way in which they are composed" (p. 50). Martinez claims that the signalling system involved in human belief states exhibits compositional productivity.

I must briefly voice an objection that will be set aside. I think that there are no compositionally productive signalling systems on Millikan's view. Millikan's account of productivity rejects this roughly Fregean kind of bottom up compositionality. This claim is defended at length in (Leahy 2014). But we needn't examine that argument here. Martinez' argument can be recast without asserting the existence of compositionally productive signalling systems and without artificially undermining his claims. In the next two paragraphs I present an amended version of his argument.

There are signalling systems for which denying meaning to icons outside any limited domain is not an option. The signalling system involved in human belief states is one example: we can have meaningful beliefs about states of affairs sufficiently distant to be plausibly outside the causally grounded domain for that signalling system (for example, states of affairs outside our light cone, or in other possible worlds if they exist). I will call any signalling system for which we cannot restrict meaning to any limited domain "complexly productive".

Martinez' (amended) argument proceeds as follows. First, regarding indexically productive signalling systems, he has argued that there is nothing that establishes which rule is the correct rule for interpreters to follow outside of the causally grounded domain. In response to this challenge, Millikan may respond that such signals have no meaning. But the same arguments establish that there is nothing that establishes which rule is the correct rule outside of the causally grounded domain for complexly productive signalling systems. However, when it comes to complexly productive signalling systems, claiming that icons outside the causally grounded domain have no meaning is not an option. For this would deny meanings to many human beliefs that are no doubt meaningful.

Having described Martinez' concern, we compare it with Kripke's. This will help us understand Martinez' concern and to see why it remains to be established whether Millikan's response to Kripke sufficiently addresses Martinez' concern. Kripke asked us to say how finitely many instances of past behaviour can determine which rule was being followed on those past occasions, and what counts as following the same rule in novel situations, when all past behaviours conform to multiple rules. What makes it the case that one of these rules was being followed rather than any of the others? Martinez accepts Millikan's response to Kripke. He accepts that Millikan has shown how finitely many instances of past behaviour can determine what rule was being followed on those past occasions, and this will determine what counts as correct behaviour in novel situations within the causally grounded domain. He argues that Millikan's reply does not determine what counts as correct behaviour in novel situations outside that domain. Martinez' challenge is weaker than Kripke's in that the cases Martinez raises a problem for are a proper subset of the cases Kripke raises a problem for. Kripke raises a problem for all novel cases of rule following; Martinez raises a problem for all novel cases outside the causally grounded domain. In response to Kripke the teleosemanticist must show that there is such a thing as conforming to a rule for some novel behaviours. In response to Martinez the teleosemanticist must show that there is such a thing as conforming to a rule for some novel behaviours that are outside the causally grounded domain. So from the premise that Millikan has found a response to Kripke, it does not follow that she has found a response to Martinez. I next examine how Millikan might respond to Martinez. But on close inspection this response reveals problems in Millikan's response to Kripke. I then show how her response to Kripke can be amended, thus resolving both challenges.

3.2.2 A Millikanian response

We saw above that the first step in Martinez' argument is to establish that there is nothing that establishes which rule is the correct rule for interpreters to follow outside of the causally grounded domain for indexically productive signalling systems. I aim to block the argument at this step: I will argue that there is a unique correct rule that interpreters "ought" to follow outside of the causally grounded domain for indexically productive signalling systems. Consequently, Martinez' challenge cannot be generalized to complexly productive signalling systems.

Suppose no rabbit has ever left the causally grounded domain in which rabbit thumps, when true and produced in accord with a normal explanation, are natural signs of rabbit predators. The "standard" normal explanation (as I will call it) for the performance of interpreter functions in response to thumps appeals to a mapping function that generates rule **S**.

> **S:** take predator avoiding behavior at the time a thump is produced; take predator avoiding behavior away from the location at which the thump is produced.

But there is also a quuslike normal explanation that requires consumers to take predator avoiding behavior at the time the thump is produced, away from the place where the thump is produced if the consumer is within the causally grounded domain, but some other behavior—say, business as usual—outside the causally grounded domain. This normal explanation would appeal to a quuslike mapping function that generates rule **Q**:

> **Q:** If in the causally grounded domain, take predator avoiding behavior at the time a thump is produced; take predator avoiding behavior away from the location at which the thump is produced. If outside the causally grounded domain, ignore thumps.

At this point, the quuslike mapping function complicates the normal explanation but by hypothesis does not increase the number of cases of function performance that can be subsumed under that explanation. So the normal explanation that appeals to the quuslike mapping function is to be rejected in favor of one that appeals to the standard mapping function due to considerations of simplicity, elegance, and empirical coverage (henceforth S&E).

So it seems that Martinez' challenge for indexically productive signalling systems can be met. The correct response for a rabbit to a rabbit thump is to take predator avoiding behavior, even if that thump is in a lab, on Mars, or in the distant future (all Martinez' examples, and assuming there have been no relevant changes in the evolutionary history of the signalling system). As a result there is no challenge for those signalling systems for which it is not an option to deny that icons are meaningful outside the causally grounded domain.

Martinez anticipates this response and offers a rebuttal. I demonstrate that Martinez' rebuttal reveals a tension in Millikan's work that he appears not to have appreciated; I then offer a modification of Millikan's view that resolves that tension and satisfies Martinez' concern.

Martinez considers the possibility that "The meaning of a new thought is its image according to the simplest and most elegant candidate in…the set of mapping functions among which Millikan's theory cannot decide" (p. 63). "The set of mapping functions among which Millikan's theory cannot decide" are mapping functions that agree with one another within the causally grounded domain but diverge in some way outside the causally grounded domain. He argues that this appeal to simplicity and elegance would make simplicity and elegance "ingredient" (p. 64) in the theory of intentionality, which is inappropriate. He writes,

> It is unlikely that simplicity or elegance will play undischarged roles in the theory of intentionality that eventually turns out to be correct—that is, it is unlikely that S&E help in making something the meaning of a language expression or a thought. Compare: one can use S&E considerations on the way to a theory of gravity, and it may well be that the simplest and most elegant among a number of plausible candidates is the right theory of gravity; but this does not mean that the notions of simplicity and elegance (as opposed to the notions of mass or field) will play a role in the right theory of gravity. Rather, it is overwhelmingly plausible that they will not. Analogously, while the notions of cause and function will likely play a role in the right theory of intentionality, simplicity and elegance most probably will not. (p. 64)

My argument to this point has established that S&E are not components of the explanation of the proper performance of the rabbit's predator avoiding function; rather, they play metatheoretical roles. However, is S&E ingredient in the account of the content of the rabbit's internal representation? A biologist's description of how the rabbit's predator avoiding device (normally) works will not appeal to S&E; rather, it will appeal to the mapping function that the scientist takes to be simplest, most elegant, and so on. But does Millikan, in describing the relationship between the biologist's description and the content of the signs, have to appeal to S&E? I will argue that she does not. Put differently, I will argue that expressions like 'simplicity,' 'elegance,' and so on do not need to appear in the right hand side of the biconditional "a sign s represents state p if and only if …" on Millikan's view.[iii]

In response to Martinez' challenge I will defend the following position. Content is determined by the system of dispositions to vary behavior in response to variations in signs that was selected for, not by the normal explanation that describes those systems of dispositions using a mapping function. A signalling system is the result of a process of selection for that builds into place a causal structure with a system of causal sensitivities, a system of dispositions. These systems of dispositions are described by mapping functions. We use S&E to eliminate hypotheses about which systems of dispositions were selected for. But content is determined by which systems of dispositions were selected for, not by the mapping functions we use in describing those systems.

These points are perhaps most clearly made in (Millikan 2004), chapter 6. She writes, for example, "consider the distinctive clucking sound that a mother hen makes when she finds food…her disposition to call has been selected for having this effect on chicks. It has been purposefully produced in order to serve the chicks as a sign of food. On the proposed theory, her call is an intentional sign" (p. 72-73). A token hen call is an intentional sign because it results from a disposition to make calls in accord with a certain mapping function. That disposition has been selected for through the benefits that calls generate for chicks (sign interpreters) and consequently for hens (producers). Moreover, the hen's dispositions to call have been selected for in tandem with the selection for of chick's dispositions to respond to calls. Millikan writes that "…this correspondence between real relations is operatively involved…in the causal mechanism of interpretation, that is, of *use*" by normally functioning interpreters (Millikan 2013, p. 83). "Correspondences between real relations" are the correspondences described by mapping functions, and a causal mechanism is a system of dispositions to respond to inputs. So we see that a signalling system is produced when systems of dispositions (or: a causal mechanisms, systems of causal sensitivities) have been selected for, one each in sign producers and interpreters.

This appeal to selected for dispositions resolves Martinez' concern. Simplicity, elegance, and similar terms will not appear on the right hand side of the biconditional "a sign s represents state p if and only if …". The job one might think was done by terms for theoretical virtues is done by terms referring to dispositional features of interpreters that fit into the causal order. The right hand side of the biconditional will contain terms like 'disposition', 'mechanism', and 'selection for', but not 'simplicity' or 'elegance'.

3.2.3 A tension between the responses to Kripke and Martinez

This brings to light a tension in Millikan's position. This response to Martinez and her solution to the problem of productivity are not jointly compatible with her claims in response to Kripke. The response to Martinez and her solution to the problem of productivity require that some dispositions that have never been activated have been selected for, while her response to Kripke requires that some dispositions that have never been activated have not been selected for, no matter how widespread they are in a population. There must be a systematic way to distinguish dispositions that have never been activated that have been selected for from dispositions that have never been activated that have not been selected for. I will offer a systematic distinction.

Let me spell out the components of the problem piece by piece. First, Millikan's account of productivity together with the response to Martinez drawn from her (2004) and (2013) requires that some dispositions that have never been activated have been selected for. Signalling systems arise when *systems* of dispositions to vary behavior in accord with variations in signs are selected for. But if a signalling system has a novel sign that is interpretable under Millikan's theory of productivity, then either (a) there is a possible value for some variable dimension of the signalling system that has never been actual before or (b) there is a combination of values that has never been actual before. Consequently, the selected-for disposition to respond to those signals has never been activated. In our bee dance example, there must be some orientation that has never been danced before, or there must be some waggle section duration that has never been danced before, or there must be an orientation-duration combination that has never been danced before. Suppose no bee has ever danced 67° off the vertical. Normally constructed sign consumers in normal environmental conditions must be disposed to respond appropriately to these signs, that is, to fly 67° off the line from the hive entrance to the sun, even though these dispositions have never been activated because the sign that activates them has never arisen.

Second, Millikan's response to Kripke—her claim that the correct mapping function is the standard mapping function, not the quuslike mapping function, even when the quuslike mapping function better describes actual dispositions to respond—requires that some dispositions that have never been activated have not been selected for, no matter how widespread they are in a population. Even if all honeybees are disposed to rest at ease in response to dances between 42° and 45° off the vertical, the mapping rule for the signalling system does not require that bees rest at ease in response to those dances. Rather, it requires them to fly off in a direction between 42° and 45° off the line from the hive entrance to the sun. This was how Millikan separated dispositions to behave from rule-governed behavior. This, conjoined with the response to Martinez, entails that the set of dispositions that has been selected for is the set of dispositions described by the standard mapping function. Now we can see the tension: it may very well be that no honeybee has ever had the dispositions described by the standard mapping function. That puts Millikan in an odd position: how can a set of dispositions that has never existed have been selected for?

We can combine these problems in a single example that illustrates all the problems that need to be solved before the response to Martinez can be considered complete. Suppose that honeybees have never performed a dance 67° off the vertical or between 42° and 45° off the vertical. In response to dances 67° off the vertical, observers are disposed to fly 67° off the line from the hive entrance to the sun. In response to dances between 42° and 45° off the vertical, observers are disposed to rest at ease. In light of this example, we need to answer two questions. 1. Why is the response that observers are disposed to make to a dance with orientation 67° off the vertical the *correct* response to make? More generally, how do we preserve Millikan's account of the interpretability of novel signs? 2. Why is the response that observers are disposed to make to a dance with orientation between 42° and 45° off the vertical not the response required by the mapping function for the signalling system? More generally, how do we preserve the distinction between dispositions to behave and rule-guided behavior, where rules must be breakable but dispositions must manifest themselves when their activation conditions obtain?

Let me try to state the problem a different way. Millikan separated dispositions to behave from rule guided behavior in her response to Kripke. There we used an example of honeybees with a "blind spot" to dances with orientation between 42° and 45° off the vertical, who are disposed to rest at ease in response to dances in their blind spot, thought that disposition has never been activated. Thus bees are disposed to behave in accord with a quuslike mapping function. But since the dispositions to rest at ease in response to these dances did not historically contribute to success (since they were never activated), and since the standard mapping function is simpler than the quuslike mapping function, the standard mapping function is to be preferred.

Combining this with the response to Martinez, though, generates problems. The response to Martinez required that content is determined by the system of dispositions to vary behavior in response to variations in signs that has been selected for in the history of the signalling system. Content is not determined by the mapping function we use to describe those systems of dispositions. But then it seems unlikely that the correct mapping function for the signalling system in our blind-spot honeybees is the standard mapping function. For the standard mapping function requires that the disposition to respond to dances with orientation 43° right of the vertical with flight 43° right of the line from the hive entrance to the sun has been selected for. But that disposition does not exist and (we may suppose) never has. Thus it seems peculiar to say that this system of dispositions has been selected for.

So the response to Kripke seems to be at odds with the response to Martinez. Moreover, we must remember that the content of a novel sign is determined by the system of dispositions that has been selected for in the history of the signalling system. Thus if there are interpretable novel signs, there must be selected for dispositions to respond to signs that have never been activated before. For if all selected for dispositions to respond to signs have been activated, then all signs have been instantiated (thereby activating the disposition), and so there are no novel signs.

3.2.4 Resolving the tension

My solution to this puzzle proceeds in two steps. First I will argue that the correct mapping function for this signalling system is neither the standard nor the quuslike mapping function. Second I will argue that the proposed mapping function both accounts for the interpretability of novel signs and, contrary to appearances, does not undermine the essential features of Millikan's separation of the normatively correct response to a sign from actual dispositions to respond to a sign.

The first point requires a distinction similar to the distinction between selection and selection for. (Sober 1984:100) draws this distinction in terms of causation. An object type has been selected when there has been a process that resulted in an increase in the frequency of objects of that type. A property has been selected for when it causes, through a selection process, increase in the frequency of objects with that property. Two properties may be coextensive in a population while one is selected for and the other not. Chins, in Sober's example, go along with jaw structures like ours; you have a chin if and only if you have a jaw. But while there was selection for having jaws of a certain sort, there was no selection for having chins of any sort. Chins have just gotten lucky, a side effect of jaws of the right type. Chins of the right sort were not selected for because they played no causal role in the processes that lead to increase in the frequency of objects that had chins.

The causal difference can be spelled out conditionally.[iv] Jaws played a causal role in the selection processes, and if jaws had been different (all else the same), the selection processes would have been different. Chins did not play a causal role in the selection processes, and if chins had been different (all else the same), the selection process would not have been different.

I must extend the distinction between selection and selection for to allow that dispositions that have never been activated can have been selected for. We might say that Sober has distinguished categorical selection for from categorical selection, but add a distinction between dispositional selection for and dispositional selection. This new distinction cannot be analysed in terms of causes, as Sober does in the categorical case, since the target dispositions have never been activated and so have not contributed causally to success. However, we can draw the distinction in terms of conditionals, in parallel to the categorical case. In our example, if the disposition to respond to dances 67° off the vertical had been different and that disposition had been activated, the fitness of that disposition would have been reduced. If the disposition to respond to dances between 42° and 45° off the vertical had been different and that disposition had been activated, the fitness of that disposition would not have been reduced. I will say that in these bees, the disposition to respond to dances 67° off the vertical has been *dispositionally selected for* while the disposition to respond to dances between 42° and 45° off the vertical has been *dispositionally selected* but has not been dispositionally selected for.

Now, which mapping function should the normal explanation for the nectar-collecting function of our blind-spotted bees appeal to? In addition to the quuslike rule and the standard rule described above, I offer the following "gappy" rule. I will argue that the gappy rule is to be preferred to the alternatives.

> **Standard rule**: If the orientation of the dance is x° off the vertical, fly x° of the line from the hive entrance to the sun.
>
> **Quuslike rule**: If the orientation of the dance is x° off the vertical, fly x° of the line from the hive entrance to the sun, unless x is between 42 and 45, in which case rest at ease.
>
> **Gappy rule**: If the orientation of the dance is x° off the vertical and x is less than 42 or greater than 45, fly x° of the line from the hive entrance to the sun.

The gappy rule is undefined for dances with orientations between 42° and 45° off the vertical; hence the name "gappy". The gappy rule seems, like the quuslike rule, to include a clause that can be simply dropped from the explanans without effecting the tightness of the relation between explanans and explanandum. But we should prefer the gappy rule to the standard rule because it avoids the flaw we have noted in the standard rule. The standard rule is flawed when combined with the response to Martinez because it requires that a system of dispositions that never existed was selected for. But something that never existed cannot have been selected for. The gappy rule better describes the system of dispositions that was selected for, including dispositionally selected for. It does not imply that nonexistent dispositions have been selected for. It also leaves out the dispositions that were merely selected, including dispositionally selected, thereby avoiding the problems we have noticed for the quuslike rule. So in the example as we've described it, the gappy rule is to be preferred to the standard rule and the quuslike rule.

Gappy rules are familiar from Millikan's work. A toaster that has no bread in it is not malfunctioning. The conditions under which its function is to be performed are not met, and so the question of whether it is malfunctioning or not does not arise. The toaster may have a broken element and be unable to toast bread, or it may be in good working order. In either case it is not at the moment malfunctioning.

I claim that a bee from our example faced with a dance with orientation between 42° and 45° off the vertical is like a toaster with no bread in it. The conditions under which its function is to be performed are not met, and so the question of whether it is malfunctioning or not does not arise. The bee that responds to that dance by resting at ease is neither functioning properly nor malfunctioning with respect to its nectar collecting function.

Now I turn to the second step of my argument. In this step I show that the gappy mapping rule accounts for the interpretability of novel signs and enables the distinction between the normatively correct response to a sign and actual dispositions to respond to a sign.

There is no change here in Millikan's position on how novel signs are interpreted. If a dance with orientation 67° should be performed, its interpretation would be determined by the system of dispositions that were selected for (including dispositionally selected for), a system of dispositions described by a mapping function. However, dances with orientation between 42° and 45° off the vertical have no interpretation.

The gappy rule also leaves room for the distinction between the normatively correct response to a sign and actual dispositions to respond to a sign, since not all of the bee's dispositions to behave are ways that the rule requires the bee to behave. The bee is disposed to rest at ease in response to dances with orientations between 42° and 45° off the vertical, but resting at ease is not required by the rule. The rule makes no requirement.

It might be thought that this room is not quite large enough, since it is still the case that all ways that the rule requires the bee to behave are ways that the bee is disposed to behave. Moreover, this seems required by the response to Martinez and by (Millikan 2013): if the interpretation of a sign is determined by the system of dispositions that has been selected for, have we built in exactly the coincidence of dispositions to behave and normative requirements on behavior that we need to avoid?

We have not. There will be coincidence of dispositions to behave and normative requirements on behavior when everything is normal. But things can fail to be normal in two ways: environmental conditions can be abnormal, and the individual can be abnormally constructed. In either case, dispositions can come apart from normative requirements on behavior. A normally constructed individual in normal environmental conditions is indeed disposed to perform its proper functions, to behave as required by the rules it is subject to. Departures from the normative standard requires a failure of normalcy, either internally or environmentally. But there is nothing that guarantees that individuals are normally constructed, or that they are in normal environmental conditions. When conditions are abnormal, rules may require behavior of an individual that it is not disposed to produce in those conditions. Thus the required separation between rule following and dispositions to behave is preserved, hence the possibility of breaking a rule. Actual performance is not equated with correct performance.

4 Conclusion

In this paper we have outlined Millikan's theory of productivity with a focus on the role of considerations of simplicity and elegance in choosing amongst alternative theories of how a signalling system works. Then we discussed two objections to the theory, one from Kripke and one from Martinez. We showed that Martinez' concern is logically weaker than Kripke's, so it remains to be established whether Millikan's response to Kripke addresses Martinez' concern. We then generated a satisfactory response to Martinez from claims in (Millikan 2004) and (Millikan 2013), but this response revealed shortcomings in her response to Kripke. We modified the response to Kripke to preserve coherence with the response to Martinez and showed that the essential features of the view were preserved.

Bibliography

Kripke, S. (1982). *Wittgenstein on rules and private language*. Oxford: Basil Blackwell.

Leahy, B. (2014). Teleosemantics: Intentionality, Productivity, and the Theory of Meaning. *Language and Linguistics Compass* 8: 197–210.

Martinez, M. (2013). Teleosemantics and productivity. *Philosophical Psychology*, 26, 47—68.

Millikan, R. (1984). *Language, thought, and other biological categories*. Cambridge: MIT.

Millikan, R. (1990). "Truth rules, hoverflies, and the Kripke—Wittgenstein paradox" *The Philosophical Review*, 99(3), 323—353.

Millikan, R. (1995). Pushmi-Pullyu Representations. *Philosophical Perspectives 9: AI, Connectionism and Philosophical Psychology*, 185-200.

Millikan, R. (2004). *Varieties of meaning: the 2002 Jean Nicod lectures*. Cambridge: MIT press,

Millikan, R. (2013). "Reply to Shea". In Dan Ryder, Justine Kingsbury, and Kenneth Williford (Eds), *Millikan and her Critics (pp. 81—86)*. Malden: Wiley-Blackwell.

Sober, E. (1984). The Nature of Selection. Chicago: University of Chicago Press.

Shea, N. (2013). "Millikan's Isomorphism Requirement". In Dan Ryder, Justine Kingsbury, and Kenneth Williford (Eds), *Millikan and her Critics (pp. 63—80)*. Malden: Wiley-Blackwell.

Notes

---

[i] I draw my description of bee dances from a video found at https://www.youtube.com/watch?v=bFDGPgXtK-U. This description serves our illustrative purposes no matter its accuracy.

[ii] Of course, dances also covary with many other things by accident, but only these two need to be appealed to in the most proximate normal explanation for the nectar-collecting function.

[iii] A referee pressed the significance of this point on me, which lead to important improvements in this paper.

[iv] I do not wish to commit to a counterfactual analysis of causation here.