**Is function a Deontic Modal Word?**

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**1.0 Introduction**

In this paper I develop a theory of function and function as a deontic modal word and phenomenon. Kratzer’s account of the semantics for the deontic modals is invoked and using her approach a formal schema for the semantics of function-sentences is proposed. My account of function is a modalized and extended version of Cummins’ systems-type account of function. In the biological and physical sciences, on this account, function is a complex empirical deontic modal property. It is built on the property of X’s doing Y well enough to enable Z, which is implicitly deontic because of the evaluative but nonetheless empirical in its biological and physical applications. This account of function resolves many of the traditional puzzles about biological and physical function, and extends naturally to include the other types of function. With a variant treatment of the semantics, this account is argued also to apply to mathematical function, where it is shown to be interestingly related to Frege’s account of function.

2.0 **Function and function**

2.1 The peculiarities of function and *function*

To see some of the puzzles about function, consider the *function*-sentences in 1a) – g) below, all of which are commonly used in ordinary speech and are consistent with our naive understanding of function-talk. They can’t all be true, we understand that, so the endeavor is to find the account which preserves as much truth and good sense as possible, and also provides the best fit with other, related, linguistic phenomena.

1a) The function of the heart to pump the blood

 b) The heart is for pumping the blood

 c) The purpose of the heart is to pump the blood

 d) The heart is supposed to pump the blood

 e) It is the function of the heart to pump the blood – even if it isn’t doing it right now because the creature is having a heart attack.

 f) It is the function of the heart to pump the blood adequately to maintain life

 g) The heart can function properly, i.e. pump the blood adequately, or it can malfunction and fail to pump the blood adequately

Sentence (c) is problematic since it commits one to a grand artificer if purpose is understood as agential goal; and if purpose is not understood that way, commits one to some theory of innate natural purposiveness. Either of these is highly problematic and generally disfavored. The common thing is to say that (c) is not part of the core meaning of function, but rather offers a theory about what a function is and that it is a false theory. I think that is correct and that c) is false for all except the agential type of function.

Sentence (b), with for, is commonly taken to be ambiguous between (c) and (d), although I think there is something different going on, and in Section 2.2 will try to explain what I think that is.

Sentences (a), (b), (e), (f) and (g) are the features that I will explain using a modal account of function and function, and whose semantics I will give in a Kratzer-style possible-worlds format.

Sentence (d), with supposed to, is a different matter. It is deontic, and if true will make function a disguised deontic word since function then implies supposed to. I will argue in Section 4 that this is in fact correct and that function is a deontic word and phenomenon, but can be empirical in its truth-conditions nonetheless and is so for biological and physical function.

2.2 The range of function-phenomena

I will begin with some examples that show the dimensions of the problem.

Biological systems

2a) the function of the heart is to pump the blood

 b) the function of lungs is to exchange gases

 c) the function of wings is to enable flight

Agential endeavors

 d) the function of a thermostat is to regulate the temperature

 e) the function of a knife is to cut

Non-biological physical systems

 f) the function of a chemical catalyst is to facilitate the reaction

 g) the function of a mordant is to fix the dye

 h) the function in steel-making of trace metals, e.g., molybdenum, is to make the metal stronger (tougher, less brittle, stainless, etc.)

Next, and more unusually but I think relevantly, these last two instances. The first is in physics where the system invoked is fundamental physics, a yes/no system of laws of physical necessity rather than a system of more/less, better/worse relations of the sort found in complex and derivative causal systems such as the biological. The second is the system of roles of mathematical objects in mathematical systems, which is also a yes/no system because mathematical roles and relations are a matter of mathematical necessity.

 i) mass in Newtonian physics functions to generate the gravitational field

And then in mathematics, consider the function of squaring. Think first about my calculator. One of its functions is squaring:

 j) my calculator functions to square numbers

Then think about the abstract mathematical object the function squaring:

k) the function squaring functions to square numbers

This sounds clumsy, but parse it carefully and you will see that it makes sense: the function squaring is the thing, and it has the function of squaring, and it functions to square numbers. I will devote considerable effort to getting all this laid out in clear and distinct ways.

But back to the gravitational force function

 l) F = g(m1)( m2)/r2

If we look just at the function with its variables removed we get:

 m) f( ) = g(…)(…)/(…)2

of which we can say f( ) is an inverse square function and inverse square functions are important in field theories.

I will return to this question at the very end of Section 2.5 where I attempt to articulate the conceptual structures of functions both empirical and mathematical. I will also argue that Frege’s conception of function (Frege 1952, 107-116; “What is a Function?”) fits my account of function. His conception of function is as a type of abstract object that has the capacity to “map”, that is, to take one object as input and yield another object as output. Input-output talk is metaphorical, but it can be made literal and I will show how.

2.3 The problematic features ‘for’ and ‘supposed to’

The ‘for’ idea and the ‘supposed to’ idea have been major problems in functional explanation. The function of the heart is to pump the blood, we say, and nod our heads. It is for that, that is the purpose it serves, we say. And going on, it is supposed to pump the blood, we say.

First, I think ‘for’ is not about purpose, and that the movement above from ‘for’ to ‘purpose’ is usually false: ‘for’ can entail purpose but it does not always or even usually. Invoking purpose seems to be a particular theory of function, and not part of its linguistic or conceptual nature, and so we can deny that purposiveness is at the core of function. Those of us who are atheists and physicalists (to say we don’t believe in a cosmic purpose) still feel perfectly able to use function-talk. But for-talk about functions seems different from purpose-talk, related but different; and so too do supposed to locutions. Purpose enables for-talk, but for-talk survives the loss of purpose. And further, it does not seem true to me that we can give up use either of for or supposed to without giving up an essential part of our common conception of function – although others disagree. But I don’t want to argue that point, and rather I am pursuing an account of function and function that will give a proper place to ‘for’ and ‘supposed to’ and will offer unobjectionable explanations of them as they occur in ordinary talk about functions.

Consider ‘for’ first. It can be construed as ‘for the purpose of’ and that leads to the artisanal account. An artifact is ‘for’ doing or being the thing the artisan made it to do or be. But in the other categories, the biological and systems functions, that won’t work. The evolutionary account of function (see, e.g., Millikan 1989 and Godfrey-Smith 1994) says that a thing’s (proper, real) function is doing the thing that explains why it was selected for and so is exhibited in successive generations, and so, in short, is why it exists. There the ‘for’ seems right just for the same reason that evolution seems to have a ‘for,’ which is because it mimics agential purposiveness. But it is not really an instance of purposiveness, so it does not really exhibit the ‘for’ character. I think there is something different to be said about ‘for’ which will give it a legitimate use and explanatory role, and I will return to that later in Section 2.5.

But ‘supposed to’ is just not available (again, barring a pre-scientific, value-laden idea of the universe). The agential account is the only one which might seem, even remotely, to provide it, but it does not, for consider:

3a) The agent made it to do A; or, made it for the purpose of doing A; or, intended it to do A

These elements just do not entail

 b) The artifact is supposed to do A

all they entail is

 c) The agent wants it to do A

We commonly make the inferential leap to ‘supposed to’ but we are not entitled to, based just on what 3a) and its variants mean. Something additional is needed and the modal theory of ought and supposed to, which I discuss in Section 3, can provide insight here.

2.4 Current theories of function, a brief survey

I offer here a survey of the currently standard theories of function and as I discuss each one, I will say briefly how each attempts to handle the typical difficulties, and will offer some comments on how relatively successful I think each approach is. It will be clear, however, that while taken together there is a lot of value in these accounts, none of the individual accounts seems to be right or even really to come close.

In his paper ‘The Modern Philosophical Resurrection of Teleology’ Mark Perlman (2004) offers useful comments[[1]](#endnote-1) on the current situation with regard to understanding function, and he offers a taxonomy of theories of function that has some merit, but some drawbacks as well. The list of theories of function I offer below is to an extent cribbed from Perlman, but without the theory-ladenness of his taxonomy.

4a) Metaphysical – reality is intrinsically both purposive and value-laden; perhaps a Platonic view (Ariew 2002, Bedau 1963-64)

b) Final cause theory, Aristotle – there are many interpreters of Aristotle’s theory of final cause, but see Ariew (2002) writing from the perspective of biological science and see Falcon (2015), ‘Aristotle on Causality,’ Stanford Encyclopedia of Philosophy, for a useful survey of the issues.

 c) Agential/artisanal theories – a thing’s function derives from the purpose of the artisan in crafting or using the thing to do the thing it does, i.e., its function is what it is intended to do, or be instrumental in doing. The divine artificer view fits here (Plantinga 2000).

d) Goal-contribution theories – a thing’s function is the contribution it makes to one of the essential life-goals of a creature, such as maintaining life or reproducing (Nagel 1979, 312; Boorse 2002)

 e) “Why it exists” theories – the function of a thing is what explains why it exists (Wright 1972, 1976)

 f) Etiological, evolutionary theories – an evolutionary instance of the “why it exists” theory; a thing’s function is what explains why it (that trait) was selected for by evolution and why it continues to be selected for so that future generations have the trait (Millikan 1984, 1989, 2002; Godfrey-Smith 1994; Allen & Bekoff 1998).

 g) Cummins’ causal role theory – functions are about the causal roles in systems of the parts of those systems; this makes functions dispositional properties of parts of systems in relation to the other parts of the systems (Cummins 1974, 2002)

h) My deontic modal theory of function, which is a modalized and deonticized Cummins-type theory, making it a theory in which functions are modalized and deonticized dispositions or capacities that are had by parts of a system in relation to other parts of the system

I will discuss these positions in some detail, enough to give a sense of them. They suffer from a set of related problems, as will become clear as we progress.

Metaphysical theories On these theories, the world is innately purposive and value-laden. Some people do still support such a theory but no-one seems to have much of an account of what this could mean. It is very hard to see how such theories fit with the scientific worldview, and perhaps more significantly, it is hard to see that theories like this have any real evidence supporting them.

Aristotle’s final cause theory There are various readingsof Aristotle’s theory of final cause. The simple (and probably simple-minded) sort of reading is this: the rock falls to earth because its “natural” state is to be down and not up. But it is unclear whether from that it follows that its falling is “for” reaching its final state, nor is it clear that that is where it is “supposed” to be. The final cause theory needs elaboration to answer those questions. Furthermore, explanation stops with the reference to cause, efficient or final, and although we now locate efficient causes within natural law and support if not exactly explain them in that way, we have no idea how to elaborate a theory of final cause. As an explanation, appealing to the idea either of a “natural state” or a “final cause” is sufficiently mysterious as to seem like no help.

Agential/artisanal theories Here function is to be explained by reference to the intentions of the agent/artisan. The function of a thing is what its maker intended it for. This type of account has the weakness that it cannot explain biological function without invoking an artisan-god, and it cannot explain causal role function as in additives in steel smelting without making that overtly relative to some purposing agent. And it cannot explain the ‘supposed to’ aspect of function at all. Just because the designer intends a thing to be or do something doesn’t mean that that is what it is supposed to do (as I argued a few pages ago).

Creaturely goal-orientation theories Function is here explained in terms of goals. For artifacts, the goal-determining entity the artisan is invoked, and this theory merges with the agential theory. For things that are not artifacts but are parts of living creatures, function is explained in terms of the goal-contribution the part with the function makes to the whole creature’s basic life-goals. So, e.g., the function of the heart is to pump the blood because pumping the blood contributes to the basic creaturely goal of staying alive. Within biology, the account has problems with vestigial functions, which are or were functions (if they are still; but that is what is disputed) which no longer make a significant contribution to the life-economy of the creature. Beyond biology, the account cannot treat the chemical examples except as agential and this is a weakness. And the account cannot explain the ‘supposed to’ element in any of the cases. Just because it makes a goal-contribution does not mean that that is what the thing is supposed to do.

And also as an additional complication, the details of the theory will depend on what your theory of goal-directedness is and so on what sorts of creatures you think are goal-directed. One might hold that only rational beings can be purposive, or at the opposite extreme one might think that purposiveness extends far down in the biological realm. This means that ‘contributes to the achievement of goals’ would give function a broader or narrower scope depending. Nor does not seem plausible to me that every living thing is goal-directed – viruses, even? Yet we have no qualms, or so I would suppose, I don’t, in talking about the functions of parts of a virus. This a problem for the theory.

“Why it exists” theories Larry Wright (1976) is the originator here, for although the intuition is common that the thing’s function has to do with why the thing exists, Wright’s is the first theory to attempt to codify that idea. The most important theories that are instances of this type are the evolution-based theories, which I examine separately below.

Wright’s (1976, 81) formulation is:

 The function of X is Z iff:

 a) Z is a consequence (a result) of X’s being there

 b) X is there because it does (results in) Z

This formulation is a general statement of the idea that as an aspect of X’s having the function Z, X is there because it does Z; and both the ‘consequence of’ and the ‘because’ are presumably causal. This is the general form of the ‘why it exists’ theory. In articulating his theory Wright does not specify what are appropriate sorts of ‘because’ but leaves the possibilities open. Because of that, it can be made to fit both artifactual functions (knives, hammers) and the evolutionary theories; but there are issues.

Although initially attractive, the theory has problems. Consider the case of the first being to discover that a shard of obsidian cuts. That creature picks it up and, perhaps accidentally, cuts with it. The function of the obsidian is to cut, yet in what sense is it there because it cuts? Well, the creature picked it up and moved its hand, and cut and saw that it cut. So then, we may suppose, the creature held onto it and used it again to cut. But, on the theory, it is only at that point that we can say that cutting becomes its function. That makes the sense in which the shard is there (“exists”) because it cuts somewhat strange. The agent continues to hold and use it – so is it ‘held in his hand’ as a stand-in for ‘exists’ that’s the relevant condition? Now the formulation no longer sounds so plausible. But the ‘why it exists’ theory does provide a sort of an explanation of the ‘for’ – the heart is for pumping the blood because, on the theory, the heart exists because it pumps the blood. Wright’s is presumably a causal explanation of the ‘why it exists’ result and if it is, then the explanation reads ‘the heart exists because it pumps the blood’ and that is how we should understand ‘for pumping the blood’. Then finally, the ‘why it exists’ theory does not fit the chemical function case and must treat it as agential. And it cannot explain the ‘supposed to’ feature at all.

Regardless, to give it a fair trial, we need some account of the ‘why it exists’ theory that fills in the details of the ‘why it exists’ logic. In the literature only the artisanal and the evolutionary/etiological accounts appear to provide instances. I have talked about the artisanal and so I’ll now go to the evolutionary account.

Evolutionary or etiological theories There are some variations in how this approach is thought to work. Here is an intuitively accessible formulation by Godfrey-Smith (1994, 453):

 A current token of a trait T in an organism O has the function of producing an effect of type E just in case past tokens of T contributed to the fitness of O’s ancestors by producing E and were selected for (over alternative items) because of this contribution to the fitness of O’s ancestors

It is hard to know what to make of the etiological/evolutionary type of theory, not because it doesn’t select out the correct instances of biological function, because it does, mostly. The only biological counterexample I am aware of is the mutation that generates a trait T\* that is successful from the start, and although successive generations of T\* will have the function yet that first instance of it cannot count as having the function because no natural selection for it has occurred. Yet intuitively the trait T\* initially has the function just as much as successive generations of it do. Does the evolutionary confirmation add some essential thing? That doesn’t seem plausible.

Millikan (1989, 2002), who is a leading theorist in this area, says that she does not pretend to offer an analysis of the everyday concept of function, that she is instead developing a scientific concept that is justified by its role in scientific explanation. Of course it has considerable similarity to the everyday idea of function, she says, at least as applied in biology, because it is doing some of the same explanatory work; but not quite the same, and without all the same features. She calls this theoretical concept the concept of a proper function.

Here is Millikan (1989, 288) giving a full definition of proper function:

 For an item A to have function F as a “proper function”, it is necessary (and close to sufficient) that one of these two conditions should hold. (1) A originated as a “reproduction” (to give one example, as a copy or a copy of a copy) of some prior item or items that, due in part to the possession of the properties reproduced, have actually performed F in the past, and A exists because (causally historically because) of this or these performances. (2) A originated as the produce of some prior device that, given its circumstances, had the performance of F as a proper function and that, under those circumstances, normally causes F to be performed by means of producing an idem like A.

I will not address Millikan’s claim to be creating a theoretical concept since I am interested in the everyday concept of function as expressed in our ordinary uses of the word function. As an account of our uses of the word function in common speech, hers fails, as she knows it does.[[2]](#endnote-2) But that account will need to be given regardless of whether Millikan succeeds in her narrower task. Linguistics is an empirical science just like biology, and there must be some suitable account of the semantics and truth conditions of our uses of function. If that is a unitary account, attributing a single lexical meaning to all uses of function, Millikan’s effort will be irrelevant. If it is an account with multiple senses of the word, hers will perhaps find a place.

Causal role theories – Cummins (1974) I will spend considerable time working with the Cummins-type of theory. I do this in part because my own modal theory is an outgrowth of his, and in part because Cummins gets so much right. He says, plausibly, that we engage in function-talk as part of our effort to understand the workings of complex systems, and that a thing’s function is always an aspect of its role in the system to which it belongs and which we are trying to understand.

Using as an example the heart’s function to pump the blood, Cummins says there is the causal structure of the heart and the rest of the circulatory system, and it has, among others, these two causal capacities: capacity #1 is to pump the blood, and capacity #2 is to deliver nutrients and remove wastes; and capacities #3, and #4, and etc., ending in capacity #n, the capacity to sustain life. It is this structure of causal capacities we are interested in, Cummins says, as part of our effort to understand how organisms work. He says that is what functional description is about. He disavows any element of ‘for’ and of ‘supposed to,’ saying they are the remnants of an earlier, non-causal, non-empirical way of looking at things.

This is the essential part of the Cummins-function relation:

The function of X is to do Y (as part of causal context or system S) iff X’s capacity to do Y is a typically necessary contribution to the system’s attaining the state or exercising the further capacity Z.

Quoting Cummins (1974; 762):

 x functions as a ϕ in s (or: the function of x in s is to ϕ) relative to an analytical account A of s’s capacity to ψ just in case x is capable of ϕ-ing in s and A appropriately and adequately accounts for s’s capacity to ψ by, in part, appealing to the capacity of x to ϕ in s

I want first to say that I think Cummins is the one theorist who is on the right track; and then I want to say several critical things.

Being a function is not plausibly relative to an analytical account of s’s capacity (making it relative to our particular scientific views at some time); but it is plausibly relative to some certain set of (some of) the facts of the matter concerning x and its capacities and its interrelations with the system s of which x is a part. I will be proposing that the truth of an assertion that the function of X is to Y will be relative to some set of facts about X, Y and s that the speaker contextually implies. So the set of facts is selected by human activity as part of making the utterance, but the facts are the facts and they aren’t relative to science or the speaker.

And notice that Cummins needs context although he doesn’t quite realize it, since there is no way that his “A – content” is contained in the lexical meaning of function, and so not in the lexical meaning of the utterance of ‘the function of X is to Y’; there is too much variation in the uses of function. Yet he needs that content and that relativity to achieve the correct truth-conditions for the utterance. What is needed is not an “account”; what is needed is some selection of facts that are proposed by the speaker as relevant to determining the truth of this particular utterance of ‘the function of X is to Y’ and relative to which the utterance has the truth-conditions it is intended to have.

So what is an example of some set of contextually supplied facts that will give an utterance of ‘the function of the heart is to pump the blood’ the typical truth-conditions? The relevant set of facts will be some sequence of capacities C1,… Ci, … Cn. C1 is pumping the blood and Cn is maintaining life and the ones between are all the intermediate capacities, although we rarely try to enumerate them all. Cummins says (1975) much the same thing on pages 757 and 758 where he proposes understanding a complex system in terms of a set of interrelated dispositions or capacities. It is the relationship between X’s capacity to do/be Y (capacity #1) and Y’s capacity to do/be Z (capacity #2) and so on for however many intermediate capacities, that enable the creature’s capacity, e.g., to live (capacity #n).

Consider again the heart example:

 The function of the heart is to pump the blood

The heart is X, and pumping the blood is what the function of the heart is, so that is Y; and in typical utterances of this sentence the capacity to live and prosper is Z. The point of a function-ascription, on this view of it, is to identify the physically important relationships among X, Y, and Z within the system S, which is in this case the living creature with circulatory system, for the purpose of explaining how the system S works. Cummins invokes the idea of a chain of dispositions or capacities with some termination condition as the domain of what functional explanation is trying to explain, namely how some particular system and some particular set of its capacities, does typically and usually enable the termination condition; or how it fails to when it fails.

Cummins’ proposal is quite attractive but there are problems. The first is that this understanding of function includes things that, so the critics say, aren’t functions at all. For instance, the capacity of one’s red blood cells to take up carbon monoxide as well as oxygen is the capacity to be asphyxiated, not to sustain life. But CO and dying fits the Cummins formula just as well as O2 and living, the critics say, yet we do not want to say that the function of the red blood cells is to asphyxiate us. Cummins doesn’t deny any of that, he just says that the O2/life connection is explanatorily much more important than the CO/death connection. But that surely isn’t right. We know we are talking about different things in the two cases. Here is another example of this sort.[[3]](#endnote-3) Suppose an acquaintance of yours is an elderly Catholic priest. He says, humorously but with a certain pain, that ‘his knees can no longer perform their function to kneel in prayer’. Of course we know what he means, and we know that even though we do not believe that his god made his knees for that purpose or even that his god exists. Yet with the mechanism of conversational implicature, the priest’s utterance is perfectly meaningful given the C-structure he contextually invokes, in which his knees are part of a C-structure with a Cn of praying.

We can account for these cases and many like them with contextually varying C-structures, invoked by speakers’ intentions. Cummins needs but does not realize he needs a contextual theory of the meanings of function-utterances. How else can he explain how ‘the function of the heart is to pump the blood’ is to be understood as involving the specific intermediate steps he intends and end with the termination condition of sustaining life? It is implausible in the extreme to say that these details are all contained in the meaning of function: that word has to be quite general in its meaning given its many uses. Yet something other than sustaining life could have been invoked, as in the CO/death example above. Clearly there is context-sensitivity; and context and speakers’ intentions are the likeliest thing to explain the specifics and that is what I propose as part of the semantics of function-utterances.

The remaining problem is that while there is a sort of a ‘for’ with Cummins-functions, there is no ‘supposed to’. The ‘for’ is because there is a termination condition, maintaining life. Cummins handles that by setting the function up in relation to a termination-condition, the last capacity to be enabled. But the CO counterexample weakens its force considerably: is the heart also ‘for causing death’? All Cummins says is that he doesn’t think the CO/death example is nearly as important as the O2/life example, which is a weak response. And about ‘supposed to’ he simply denies that it is or can be correct for an empirical concept of function and he, like almost everyone, thinks we must give it up as a remnant of our earlier, non-scientific thinking.

Cummins does not think the etiological/evolutionary theories of function are right[[4]](#endnote-4) (Cummins 2002, 157-172), but this is a peripheral to his main argument.

Conclusions I conclude that none of the accounts of function that I have examined here is without significant problems. Each sees something important, but none can work that insight into a unified account of the whole. And in addition to those individual weaknesses, none of them can offer any explanation, regardless of how remote, for why we keep wanting to say ‘the heart is supposed to pump the blood.’ They cannot give any suggestion at all as to how that might work, can only tell us it cannot, that we are deluding ourselves. We have learned to be suspicious by now of that kind of flat denial, for almost always there is some sense to be found. I conclude that none of the traditional accounts offers a satisfactory treatment of function.

And in addition to these quite serious problems with all the accounts, few of them except Cummins’ account pays much attention to what I think are the empirical and conceptual structural features of functions. I think examining those features will offer us some insight into our problem, and that is what I will do next.

2.5 The conceptual and empirical structure of function

What are the elements of functions and how do they relate among themselves? I want to work my way into the problem of the structure of functions, to ask what are the elements involved in asserting the function-sentences below, and what they are saying the world is like. I believe it will confirm some of Cummins’ views and allow me to see how to extend them considerably.

C-structures in biological function

I will begin with:

5a) The function of the heart is to pump the blood

There is the heart, which has the function and does the thing the doing of which is the function, namely the pumping of the blood. Is that all, then? A two-part relation? But then there is sentence b) below, which seems also to be true:

 b) The function of the heart is to pump the blood adequately to support life

The latter sentence introduces the norm of the function, ‘adequately to support life’, which gives the standard of performance required for the function to be said to be performed adequately or properly. If it doesn’t perform to that level it is malfunctioning, we say. This additional element seems to be an essential part of the function of the heart, but where does it come from? In the artifactual case, the artificer establishes the standard of performance. Without an artificer, we seem to be invoking an internal norm and thereby attributing value, which just drops normativity right in the middle of the account with no justification or explanation.

Now I want to expand the above sentence b) into c) below; I will return to address the above objection in a moment.

c) The function of the heart is to pump the blood … to distribute nutrients … to nourish the cells … to maintain health and growth in the cells … to support tissue repair and maintenance … to maintain life

Sentence c) has the structure:

d) The function of the heart is to enable C1 well enough… to enable C2 well enough… to enable C3 well enough… to enable Ci  well enough… to enable Cn

Or, more formally:

e) The function of the heart is (to well enough enable C1 … to Ci … to Cn-1 … to enable Cn)

In the C1 … Cn structure, the Ci are capacities and each Ci is enabled well enough to enable the succeeding Ci+1 well enough … to enable Cn which is a yes/no condition and is either enabled or not. The yes/no condition identifies the terminus of the chain; it is the thing we are interested in explaining. The Ci are causally linked such that, in the causally complex biological cases, each Ci is typically and usually necessary but not sufficient for each Ci+1 unless a number of “other things being equal” conditions are added. The heart pumps the blood more or less well to distribute the nutrients (usually and typically and other things being equal), the circulated blood distributes nutrients more or less well to nourish the cells, the distributed nutrients nourish the cells more or less well to maintain cell health and growth, and so on. So the series of more/less conditions terminates with a yes/no condition, which provides an end-point that specifies what it is we are trying to explain, and also what is to count as success or failure. But it counts as success or failure not by our decision that it is so, but by what it does in virtue of its location as the end-point in the sequence and relative to its location at the end-point of the sequence. That end-point is part of that C-structure, and by invoking that C-structure, we invoke that end-point. Thus in saying that a thing’s function is C we are invoking some complete C-structure. As we will see later, this will work just right given the semantics I will be proposing for function, in which the speaker invokes through context (conversational implicature) a factual background. For function, that factual background will be the invoked C-structure. This is the nature of the context-sensitivity of the assumed background conditions that Cummins needed but did not have.

Thus the C1 … Cn relation provides the ‘for the sake of’ because of the contained end-condition the Cn. Following out this line of thought, the function of the heart is to be understood either as (1) C1 relative to the sequence (C1 … Cn) or as (2) C1 as part of the sequence (C1 … Cn). Either way, this idea of function is relational and functions are to be understood relative to some particular C-structure. The speaker in asserting some function-statement, provides and invokes via context or conversational implicature some C-structure and introduces it into the meaning of the utterance. I will address this mechanism at some length in my explanation of Kratzer’s theory of the semantics of the modal auxiliaries. She deploys context-dependence to great effect there, and I am arguing that it works equally for function-statements. But the linguistic argument will come later. My concern here is to locate and understand the relevant C-structures.

So we now have the norm of the function, which in the typical biological case is ‘adequately to maintain life’, because that is what we are interested in. And we have a ‘for,’ generated by the relativity of the function to the referenced C-structure with its Cn end-point.

An objection: isn’t this just a different way of saying that the purpose of the heart is to pump the blood to maintain life? No: what my account does (and it will be easier to see this once the full semantics is in place) is to invoke the particular C-structure and then say, relative to that structure, that the function of the heart is to pump the blood. Its function relative to that C-structure, as part of that C-structure, is to pump the blood to maintain life. Relative to a different C-structure the heart might have a different function. When you say ‘the function of the heart is to pump the blood’ that is to be understood as relative to some contextually indicated C-structure. The heart does typically and usually pump the blood; and typically and usually life is maintained.

The typical Cn value for biological systems is the capacity to maintain life but it doesn’t have to be. Taking life as the end-point of the sequence explains why the ‘CO/asphyxiation’ pair I discussed earlier does not identify a function in normal conversation. When we say it without any additional context-setting, we are saying it against the naturally assumed Cn end-point of maintaining life. But if we change the context, if we say ‘the function of the lungs is to take in CO which leads to asphyxiation’ and say it in the context of a discussion of assassination technology, where the Cn value will be causing death, then the function of the lungs will be asphyxiation.

Thus the Cn end-point gives us both the strong ‘for’ and the means to say what ‘adequately’ in ‘the function of the heart is to pump the blood adequately’ contributes. This is the norm of the function, what is to count as adequate performance vs. malfunction or incorrect performance. This resolves the CO/death, the kneeling case and similar puzzles, since by contextually altering the C-structure, we get significantly different interpretations of ‘the function of the heart is to pump the blood’.

Now what about other sorts of functions? What I have established, at least for biological function, is the three-part nature of functions, namely (1), the thing that has the function, (2), the capacity for doing the thing which is the function, which is C1, and (3), capacities C2 through Cn, thus making up the C-structure. And I have argued that a context-sensitive type of semantics will be necessary to give proper truth-conditions for function-utterances. This seems right for biology, but will it work for other sorts of functions?

C-structures for Artifacts

We talk easily about the functions of artifacts. We say

The function of knives is to cut (adequately for one’s normal and usual purposes in the instance)

So what are the C-structures here?

A scalpel is a kind of knife, yet the function of a scalpel is to make surgical cuts, and that is not the function of an ordinary knife. A sushi knife is certainly a knife, yet the standard of cutting expected of it is much superior to the standard appropriate to a typical kitchen paring knife. These different standards appear in the norm, saying what is an adequate performance, but they derive from the “end” of the function, the capacity or condition Cn, which is what the performance of the function is intended by the agent to result in.

Capacity Cn identifies what the correct sort of cutting is, e.g., surgical incision, slicing fat belly tuna in the sushi-appropriate way, peeling an apple, and etc. So the C-structure chain is short here, unlike in the biological case, where it can be quite long. Here we have C1, the cutting, and C2 which is the result of the cutting, namely the cut material being cut in the required way. So C2 = Cn where Cn is the agent’s goal, which is to produce a surgical-quality incision, a sushi-quality cutting of a piece of tuna and etc. Other sorts of artisanal function C-chains can be longer if the causal linkage is more complicated as it will be when the agent creates some artifact which is mechanically complicated and goes through multiple Ci to enable Cn.

But notice that depending on how you express the function, there can be only a single C-segment:

 The function of a sushi knife is to make sushi-quality cuts in the making of sushi

In the agential cases, the goal allows us to express the function as a one-step operation with only one capacity, the Cn. The multi-stage C-structure in biological function is found there, and in other cases such as the chemistry cases, below, because those causal structures typically are quite complicated. In cases like this the C-structure complexity is bundled into the detailed outcome-description; there are no causally separated steps.

Non-biological, non-agential functions

Next, I want to consider non-biological, non-agential cases, as for instance in chemical reactions:

The function of the mordant is to fix the dye in the fabric

The doing of the function is what the mordant does in the chemical reaction (whatever that is, we don’t need to know the chemical specifics) and that is C1. Then C2 is the dye bonded into the fabric making the color in the fabric more permanent (either as an aspect of the dye molecule or of the bonding to the fabric, but again the chemical details don’t matter for function-talk). Cn is the termination-point and is the fabric being dyed to the degree of permanency that is the Cn. But how is that point set? Doesn’t that invoke the agent, and so disprove my claim that chemical systems functions are non-agential? No, what is at work here is the transition from a more/less Ci condition to a yes/no Cn condition. For although it is we who say “permanent enough” the level of permanency is whatever it is in the C-structure invoked and that is the level the function is determined against. Of course we could articulate a different function, against a different level of permanency, but then the same considerations apply again.

We can say this another way. Although the whole structure that comes about is in service of the cloth-dyer’s descriptive needs, the attribution of function considered narrowly is a self-contained thing that does not refer to the agent’s ends but to the C-structure being invoked. C1 is the fixing of the dye, C2 is the color of the dyed fabric made more permanent and Cn is the dyed fabric being made permanent to the indicated degree. You can object that permanency also is a matter of degree, and in some contexts it is properly so understood, but in others it isn’t. The point is that while we determine how permanent a thing must be to be counted as permanent, given that we mean that by our words the color is permanent or it isn’t. Of course speakers invoke the C-structures they do for their own purposes, but that is the nature of speech. It doesn’t mean that the function is relative to speakers’ purposes.

This same sort of account can be given for other chemical process functions, as in the function of trace metals in steel-making, the function of catalysts in speeding chemical transformations, and so on. And I want to make a point here about why function-talk is so useful. Notice that in discussing cloth-dying I said several times how the chemical details didn’t matter. Function-talk is so useful to us just because it lets us talk about complicated causal processes even though we know only a little bit about the details of those processes, just enough, really, to locate the attachment-points for our function-talk. We can then usefully talk about the processes and how to manage them, even though we know very little about the actual chemistry involved.

Functions as social or conventional roles

The dictionary gives ‘role’ as a meaning of ‘function’ and we know what is meant. ‘The chief financial officer of an institution manages the institution’s finances’ we say; ‘that is the function of the position’ we say. Those are noun-forms of function but we can say functions to as well, if a little less handily: ‘the CFO functions to ensure the institution’s financial soundness’ we say, ‘that is the CFO’s function’. The capacity in question is the capacity to manage the finances, and we can summarize all of that in one capacity Ci or we can enumerate it in many, but the termination condition Cn will be ‘manage the institution’s finances to ensure the institution’s stability, mission performance and continuity’ (for not-for-profits; profitability and continuity for for-profits).

Social functions

Social functions may seem like an exception to my theory – but they are not, mostly. Think about a dinner party, how as the wife and husband stand at the door waving goodby to their guests, the wife says to the husband ‘that was quite a successful evening’. The point is that the dinner party is an artifact, crafted by the hosts to achieve certain ends – among which is pleasure, certainly, but other ends as well. And as we all know, dinner parties may succeed, or they may fail dismally. Artifacts have functions and so does the dinner party. Spontaneous social events may be an exception, things that just happen yet are clearly “social” and an “event”. Most social events are purposeful, however.

The earliest uses of function, in approximately it’s current sense, occur in medieval French, where they are applied to social events (see the Oxford English Dictionary’s entry on function). At this distance in time, it is somewhat difficult to be sure, but the application seems to be to major social occasions which serve specific purposes – the baptism of a child, a marriage, a presentation at court. These things “do something” in that the proper performance of the event brings about or achieves an outcome. If things are not done properly, the outcome may be flawed or even invalidated. This understanding fits our contemporary understanding of function. If the word in medieval France were also applied to casual gatherings with no particular function or purpose, with nothing achieved or intended to be achieved except perhaps pleasure, then the word so used would have had a different meaning, and would have combined the two meanings in a way we now would feel uncomfortable with. Distance in time makes it hard to know.

The OED also lists as a meaning of function, (mere) activity; but then the examples all invoke purposiveness, so I think the “mere activity” suggestion is misleading and I think not intended by the editors.

Function in physics

My example from Newtonian physics was the following: gravitational force between two or more masses is a function of the masses generating the gravitational field and the distance between the masses, and then of the interaction of the masses with the gravitational field to generate gravitational force.

The equation is:

F = g(m1)(m2)/r2

That means that mass and distance are the variables and does not mean that they have or are functions. What ‘has’ the function here, in the sense that the heart has the function of pumping the blood, is the Newtonian universe itself. The variables of mass and distance are elements of the enabling conditions. The equation:

 (m1)(m2) = (F)(r2)/g

would seem to be the right equation to use to say that mass functions to generate gravitational force. This sort of invertability is on one hand an unfortunate ambiguity and will require extra care to manage without confusion; but on the other hand, it is a direct consequence of how equations work. You can take whichever value you want as the variable and take the rest as the function; you get to choose, and your choice is driven by considerations of what you are interested in.[[5]](#endnote-5) Compare ‘It is the function of the blood to be pumped by the heart’ which we see is true, but feel is derivative on ‘the function of the heart is to pump the blood’. This appears to be a problem with a complicated set of relations and to suggest issues about explanatory and ontological priority. I will not stop to pursue it here.[[6]](#endnote-6)

But now I want the function to be captured in the right-hand side of the force-equation. Here it is before it is instantiated by the values of the variables:

 f(…, …, …) = g(…)(…)/(…)2

and then when interpreted variables are inserted:

 F = g(m1)(m2)/r2

For this example, the C-structure will be as follows. C1 is the capacity of masses m1 and m2 to generate gravitational fields. C2 will be the capacity of masses m1 and m2 to interact with the fields so generated, and C3 for the masses to be attracted toward each other with a force F.

Or, looked at from the other direction, where mass is said to function to generate the force, we have as the pure function:

f(… , …) =(…)(…)2/g

and with interpreted variables we have

(m1)(m2) = (F)(r2)/g

So here we can say ‘the masses in Newtonian physics function to generate gravitational force’.

A potential objection: if one can say ‘mass functions to generate gravitational force’, there is no reason to use function to say it if there is no reference being made to the broader causal structure of Newtonian gravitational theory, of which that particular thing is a part. You should more properly say ‘mass causes gravitational force’. For function-talk is typically about how one part contributes to a larger causal structure. We say ‘the function of mass in Newtonian physics’ and that suggests that the range of the C-structure is throughout the core network of causal relations of Newtonian physics. Perhaps it doesn’t need to stretch that far, but that’s what’s suggested. And that’s all true. The upshot is that the usefulness of function-talk in fundamental physics is small but nonetheless perfectly coherent.

But the other element that function contributes to the description is the deontic. You can, based on the sentence:

 It is a function of mass in Newtonian physics to generate gravitational force

move on to the deontic:

 Mass in Newtonian physics must generate the gravitational force

This is of course the necessity of physical law, but because function is a deontic modal dispositional property, or so I am arguing, the necessity of physical law manifests itself as the deontic modal word must and the modal property it expresses. And we need this connection, because otherwise a natural “law” is not really a law, is really only a true universal statement and does not itself have any necessitating law-like force: it just isn’t literally a law if there isn’t a sanction. Seen that way, natural law seems to be only metaphorically law-like. It is the deontic character of function, deriving from the underlying deontic modal dispositional physical properties that are invoked in the function, the ‘doing Y well enough/correctly to enable Z’ property, that brings the deontic element and generates the must and the necessity.

But how does the necessity come to manifest itself as a must rather than a supposed to, as it was doing in the biological instances of function? Notice that there is no ‘more or less well enabled’ condition here as there was in the cases of biological or chemical system function. It is a yes/no condition. If they are to be elements in a Newtonian universe, the masses do and must generate the gravitational field, and the masses are and must be attracted by it to precisely the degree that they are, and that is where the deontic comes from and what it expresses. The function of mass is to rightly or correctly generate the gravitational field, meaning in accordance with Newtonian physics; and then in interaction with the field, to rightly or correctly generate the gravitational force. The evaluative may seem gratuitous here, unlike in the case of the heart where ‘pumping well enough to sustain life’ seemed to have important content. But it is not gratuitous, as becomes clear once one sees that the ‘rightly’ or ‘correctly’ qualifies how C1 enables C2. And of course C1 must enable C2 in the way of Newtonian physics if the enablement is to be done correctly. So we use must and not supposed to because supposed to aligns with more/less, better/worse in the semantics of the deontic words, and must aligns with yes/no, correct/not-correct, right/not-right. I will discuss this at greater length in Section 3 and again in Section 4.

Function in mathematics

I am going to begin by quoting from Wikipedia (Wikipedia 2016, ‘Function (mathematics)’), since I think it counts as common speech, although somewhat sophisticated. My purpose here is to investigate what “we” mean by function in mathematics, and not necessarily what the mathematicians mean; although I do need to be able to show how ordinary speech relates to the mathematical.

Consider this graphic and brief text from Wikipedia



 A function *f* takes an input *x*, and returns a single output *f*(*x*). One metaphor describes the function as "machine" or "[black box](https://en.wikipedia.org/wiki/Black_box)" that for each input returns a corresponding output.

Wikipedia is right to say that this is a metaphor, since a function is not a machine with an input and an output. But if we abstract sufficiently, the metaphor can become truth. For if we take ourselves to be talking about some abstract object (“machine”) that has the capacity to assign to each input a specific output, we are talking about something that seems to fit the idea of a thing with a function. The capacity to do that, to assign a particular output to each input, is the sort of capacity or structure of capacities that functions have. At its most abstract, we call that “machine” that performs the function a function: the abstract object the function is nothing but a thing with the capacity to perform that function.

So let’s start with a machine with a function, and then work toward functions as abstract objects. In this example I will use my old Hewlett-Packard pocket calculator, the kind that uses reverse Polish notation, and I will use the function squaring. Because it uses reverse Polish notation, you enter the argument first, and then the squaring as exponentiation to the two. The function on the calculator is actually exponentiation which is a binary function with two arguments: you enter the number to be exponentiated first, then the number of the exponentiation and then the exponentiation function. Combining the last two entries implements the squaring function. The calculator has the capacity to square, and it does it, when you do the inputting, i.e., do part of the enabling. It has the function of squaring in virtue of having a complex logic built into its electronic parts, such that when you enter the arguments and press the exponentiation key, it delivers the square of the argument. It has those capacities. The capacities are physical but have mathematical dimensions; they are implemented by contingent and empirical events and conditions in the world.

Now think of ( )2 as a thing (a thing denoted by the symbol made up of the brackets and the exponent 2). It is a thing that has the function of squaring but has had every other property removed. That is the abstract mathematical thing which is the function squaring and which has the function squaring. If it is combined with – if it is enabled by – the correct sort of object, which is to say a number and not, e.g., a geometric plane figure, it functions to yield the number that is the square of the number that enabled it. So just to be clear: we have the infinitive form *to function to*, the verb form *functions to* and the noun form *the function.* And so for the fully abstract mathematical object, we have *the function functions to… .* The mathematical function squaring functions to square.

Wikipedia goes on to say

 In mathematics, a function is a relation between a set of inputs and a set of permissible outputs with the property that each input is related to exactly one output

And then it adds this:

 In modern mathematics, a function is defined by its set of inputs, called the *domain*; a set containing the set of outputs, and possibly additional elements, as members, called the *codomain*; and the set of all input-output pairs, called its graph.

The point about this last definition is that it abandons the machine analogy of the function as an object with the capacity to generate the set of ordered pairs by matching a correct output to each input. Instead, the abstract objects which are the sets of the domain and codomain and the set of ordered pairs <input,output> are together taken as the definition. Just before this, Wikipedia had said that a function is a relation between a set of inputs and outputs, leaving it open how the relation is established. An abstract entity a function can be proposed to do it, or one can invoke the set of ordered pairs which simply displays the relationship.

Perhaps this is what one should expect in mathematics, since mathematics takes the “god’s-eye view” in which there is no need for a function to generate the set of ordered pairs because god can contemplate the whole potentially infinite set in one act of cognition. We can’t, of course – except via a function’s generative capacity, which is what I did for squaring. But the question whether mathematics can conduct its affairs entirely in set theoretic terms with only set theoretic objects, or whether it will need functions as abstract objects with capacities is presumably not about human limitations but about conceptual possibilities. The question more broadly would seem to be which sorts of abstract objects mathematics needs, sets or sets and functions and whatever other sorts turn out to be necessary as well, such as numbers. I can’t begin to answer that and I won’t even try. But what this resolution does is to suggest a clear relation between the two views.

For consider

 The set F = {<a1, b1>, <a2, b2>, … ,<ai, bi> … } and so on until the set is fully exhibited or if the set is infinite, then on infinitely

and

 The set F\* = {<ai, bi> | ai = f(bi) for all b}

and

 F = F\*

The sets F and F\* are identical, but for F the set of ordered pairs is given by presentation, as it were, and F\* gives the same set of ordered pairs by using the abstract object f( ) to generate the set by mapping each b-value onto a corresponding a-value.

And consider this relationship:

 The set BF = {p1, p2, p3, … pn} where the pi are all the persons who are bureaucratic functionaries

 The set BF\* = {pi | f(pi) is true for all p} where f is the function of performing bureaucratic functions professionally and which, when f is applied to all people p in turn, selects the bureaucratic functionaries as those people of whom f( ) is true

The relation between the set BF that is exhibited and the set BF\* that is generated by the f( ) = bureaucratic functionis parallel to what I have been calling the relation of “deriving from” – and what I mean is that the meaning of bureaucratic functionary depends on the meaning of bureaucratic function. But that the set of ordered pairs of mathematical objects that are <f(b), b>, i.e., the set <a,b>, is in some way “derived” from the function f( ) is not a claim one wants to make about mathematics; that is again a deep and difficult question in philosophy of mathematics.

Frege on function

I want now to discuss Frege. He developed an account of mathematical function as a kind of abstract thing with the capacity to map or order. I think my account of function parallels Frege’s in many important ways, and I want to investigate those parallels and any differences. These quotations are from Frege (1952). The first is from ‘What is a Function?’ and the second is from ‘Function and Concept’.

 The peculiarity of functional signs, which we here called ‘unsaturatedness,’ naturally has something answering to it in the functions themselves. They too may be called ‘unsaturated,’ and in this way we mark them out as fundamentally different from numbers. (‘What is a Function?’ p. 115)

If we read this literally, Frege is telling us that functions are unsaturated, as we have of course heard, but also that the signs for functions are also functions and so are unsaturated. This is very interesting. Consider this next quotation:

 Statements in general, just like equations or inequalities or expressions in Analysis, can be imagined to be split up into two parts; one will be complete in itself, and the other will be in need of supplementation, or ‘unsaturated.’ Thus, e.g., we split up the sentence

 ‘Caesar conquered Gaul’

 into ‘Caesar’ and ‘conquered Gaul.’ The second part is ‘unsaturated’ – it contains an empty place; only when this place is filled up with a proper name, or with an expression that replaces a proper name, does a complete sense appear. Here too I give the name ‘function’ to what this unsaturated part stands for. (‘Function and Concept,’ p. 31)

Here again he is telling us that both functions and the linguistic expressions that denote them are unsaturated – which must mean that the linguistic expressions are themselves functions. Is this coherent? The function denoted by the linguistic expression is presumably the semantic content of the linguistic expression, and it is saturated by its object to denote the True, according to Frege. A function maps its object to The True when the function is a semantic concept which has been appropriately saturated with an object.

Fregean function in mathematics According to Frege, we have function-expressions, which are items in the language we use to talk about the mathematics, and we have corresponding abstract mathematical objects which are the functions. (So we will have the same problem here as above, in being clear whether we are talking about the function or about the expression in language that denotes it.) Frege says that a function is a mathematical thing that maps objects, typically numbers but not always, to yet other numbers or other mathematical objects. In order to see how the Fregean idea of function works in mathematics, we can apply the ‘Caesar’ procedure to the right-hand side of our interpreted gravitational force equation expressed in interpreted variables. The equation with all variables filled expresses an identity:

 F = g(mi)(mj)/rk2

If we strip out the variables which identify the argument-places and thus expose the function-structure, we get the pure function

 f( ) = g(…)(…)/(...)2

This is the functional expression with its unsaturated places empty and indicated by dots. It is the function, the set of pure relations, we want to say. We can think of the expression on the right-hand side as a uniquely crafted name for the function. We get an identity when we fill the gaps with interpreted variables:

 F = g(m1)(m2)/z2

Frege’s account of function and mine The Fregean conception of function has important similarities to my account of function, but how alike are they? I began my account of function with to function to and the structure of capacities invoked by its uses in utterances about biology. Frege begins with the idea of the function itself as an abstract object with some structure of capacities. (Frege differentiates sharply between objects proper, which are not functions because lacking the capacity to be saturated, and functions, which I have called abstract mathematical objects and which do have capacities to be saturated or enabled.)

I concluded my account with the noun form which in mathematics names the fully abstract mathematical entity which possesses some structure of capacities. Frege’s function is something with a capacity or structure of capacities, just as is mine. He says that a function is unsaturated to get at the point that a function has the capacity to combine with some suitable object and so to become saturated (Frege) or enabled (me) by that object, and to then yield some other object as result of that combining. He characterizes the differences among functions in terms of two features, 1), what kinds of things will saturate them, and 2), what kinds of objects result from the saturating. Both these features are properties of the function, not of the saturating object, he holds. I have expressed those differences in terms of 1), which potential inputs correctly enable the function and which other inputs do not correctly enable it; and 2), what the outcome of a correct enabling is, i.e., what object is the result of that enabling. And I also hold that both these conditions are properties of the function.

The first objection to the identification of my function and the Fregean function will surely be that my account of function is based on treating functions as structures of capacities; but capacities are or appear to be empirical, which is to say causal and temporal, and mathematics is neither causal nor temporal. But I think we talk about capacities more broadly and in a way that includes non-temporal and non-causal capacities. ‘It is a capacity of the predicate to be satisfied by some objects and not by others’ we want to say. ‘It is a capacity of reason to differentiate right from wrong’ Kant said on a certain understanding of him. And we need to say of possible properties and possible objects that the possible property can be instantiated by appropriate possible objects, yet we are certainly not speaking about something in time, or something with causal powers. It seems that we just do extend the meaning of capacity to include things that are not physical, that are matters of metaphysics, logic and mathematics.

I think there is a literal sense of capacity at work in metaphysics, logic and mathematics. Here is how this can work. Capacities are modal properties, and ascriptions of capacity are about what would or could obtain if various other conditions were to obtain. Empirical conditions are one sort of condition. Ascriptions of mathematical capacity are about what would or could obtain given various mathematical combinations, ascriptions of logical possibility are about what would or could be possible or true under various possible or actual conditions, and ascriptions of empirical capacity are about what would or could obtain given varying empirical conditions. It is this broad sense of ‘x’s capacity to do or be ϕ,’ which is equivalent to, or at least is explained in terms of, the modal fact that x would be ϕ given certain conditions, that gives us this generalized sense of capacity. And with this broader sense of capacity, I conclude that my conception of function seems to fit Frege’s conception of function and locate it as a special case. Differences may be discovered as the details are worked out, but I will not pursue the comparison further here.

Fregean functions in linguistics There is another interesting aspect of the Fregean function, which is its use currently in formal semantics as that is pursued in modern linguistics. See, e.g., Heim & Kratzer (1998), Semantics in Generative Grammar who cite Frege as an important intellectual predecessor. They are addressing the problem of how semantic elements combine into larger semantic elements such that the semantic contribution of the larger element is constructed in some ordered manner from the semantic contributions of the smaller elements. Heim & Kratzer (1998, 3) invoke the Fregean conception of function to explain linguistic semantic combination. What they call the Fregean conjecture about the nature of semantic composition is this: 1), unsaturated semantic entities have capacities to combine with other semantic entities to create new saturated or unsaturated semantic entities; 2), the semantic contributions of the newly created entities are to be understood in terms of the combinations of the semantic contributions of the combining entities acting through rules of combination embodied in the functions; and 3), the conditions of successful saturation or correct enablement of a semantic function by another semantic entity are the conditions that, along with other features of the combining entities, determine the semantic contribution of the resultant semantic entity.

They cite, on that same page 3, the quotation from Frege I offered:

 Statements in general, just like equations or inequalities or expressions in Analysis, can be imagined split up into two parts; one complete in itself, and the other in need of supplementation, or ‘unsaturated.’ Thus, e.g., we split up the sentence

 ‘Caesar conquered Gaul’

 into Caesar’ and ‘conquered Gaul.’ The second part is ‘unsaturated’ – it contains an empty place; only when this place is filled with a proper name, or with an expression that replaces a proper name, does a complete sense appear. Here too I give the name ‘function’ to what this unsaturated part stands for. (‘Function and Concept.’ P.31)

They also cite Lewis (1972), Montague (1974) and Cresswell (1973) as philosophers also pursuing the Fregean conjecture. See also Partee (1989) for historical background to the movement to formal possible worlds semantics in linguistic semantics.

So we see, in general, how functional composition might work, But what about truth-conditions, how do they arise? They are essential, and we need to see how to get them into the story. Heim & Kratzer do that in one way but there is another approach that shows the very close connection between correct functional enablement and truth conditions. ‘Correct’ is an evaluative, and ‘true’ often seems to act like one (both are objective evaluatives when used with regard to predicative enablings). Either way, in semantic construction they must have a close connection, and indeed they do. Here is that connection. Predicates differ in what they can be saturated or enabled by. When that capacity to be saturated or enabled is accomplished by something, e.g., when the referring term being offered for combination with the predicate-term is an instance of a correct object for that predicate, enablement or saturation occurs, and the now saturated entity, sentence or proposition (as Frege says) denotes the True. The conditions of correct enablement are the conditions of successful saturation and are the conditions of truth, and that is our connection.

But we don’t need to invoke truth, we can leave the True and the False as either the denotata of sentences and propositions or as properties of them, and approach ‘correct’ without using them. We can say that a predicative enablement is correct iff the property denoted by the predicate is instantiated by the object denoted by the referring term. Since we already have it on this theory that the predicate denotes a property and the referring term denotes an object, and the referring term saturates or enables the predicate iff the object denoted by the referring term has the property denoted by the predicate term, correct predication occurs iff the predicate’s denoted property is instantiated by the referring term’s denoted object. And therefore those things, the correct object instantiating the correct property, are the truth conditions for the sentence. The sentence, in being correctly constructed semantically, i.e., constructed by means of correct semantic functional enablements, displays its truth conditions in those functional enablements. The truth conditions of a sentence are the conditions of correct enablement of the functional components of the sentence.

2.7 A sketch of the semantics for function

I want to finish this Section of the paper with a very brief sketch of what the truth-conditions for function-sentences will be. A more detailed presentation is found in Section 4.

As earlier, a generalized necessity operator works as follows:

 Nec-p is true at the world of evaluation iff p is true at all the worlds accessible from the world of evaluation

This is true for all the sorts of necessity. We tailor the accessibility relation as needed to correctly model the “meanings” of the various types of necessity we are interested in. Often the differentiation is factual, meaning that some set of factual conditions marks out the set of accessible worlds (which is typically some sub-set of the set of all possible worlds, possibly small and local); and this is the case for physical and most other sorts of modal necessity, although not metaphysical necessity of course.

For the deontic modals, Kratzer uses two distinct elements to characterize the accessibility relation, one factual and the other normative. So, e.g., for ought she has:

 O-p is true at the world of evaluation iff p is true at all the best worlds of the worlds of the factual setting, as ordered by the normative ordering source

Similarly for the “how well enabled” class of function-statements, the form is parallel to that for ought:

 F-p is true at the world of evaluation iff p is true at all the well-enough enabling worlds of of the invoked C-structure factual setting, as ordered by how well the C-elements are successively enabled

In the well-enough enabling worlds,all the elements of the C-structure will be well-enough enabled to fully enable Cn, the termination condition. (Notice that I have in effect replaced best in the semantic formula for truth-conditions with good enough (well-enough enabling). This is a major change and I argue it in the next Section.)

For the “correctly enabling” class of function-statements, we will have:

 F-p is true at the world of evaluation iff p is true at all the “correctly enabling” worlds of the invoked C-structure factual setting, as ordered (sorted) by whether the C-elements are correctly enabled

In the next Section, I will present Kratzer’s theory of the modal verbs and auxiliaries in enough detail to allow the reader to understand and evaluate my proposal for a semantics for function-statements, which I present in Section 4.

3.0 **Kratzer’s semantics for modal verbs and auxiliaries**

3.1 Kratzer’s Approach

I’m proposing that for function and function, the verb form to function to which names the activity is more basic than the noun form, in that we understand the reference of the noun form based on the meanings of the verb form. I claim to function to is one of the deontic modal verbs and auxiliary verbs and so is related to ought and must and supposed to and have to and can and may. The most widely accepted and most influential account of the semantics for this class of words is Kratzer’s (1977, 1981, 2012). I am of course setting aside the alethic modals of metaphysical necessity and possibility, which take a different account with a much longer history. In her papers ‘What Must and Can Must and Can Mean’ (Kratzer 1977) and ‘The Notional Category of Modality’ (Kratzer 1981), and in her book Modals and Conditionals (Kratzer 2012) which collects those papers as well as others, Kratzer sets out an interesting and very compelling theory of the semantics of these words, a theory that is now broadly accepted in linguistics. Many other linguists have contributed,[[7]](#endnote-7) and before the linguists, philosophers. Partee (1989) provides a useful survey of the philosophical and linguistic history of the movement to a formal possible worlds semantics in linguistics. Heim and Kratzer (1998) offer a systematic introduction to this approach to semantics of natural language. Portner (2009) provides an approachable exposition and commentary on current thinking in linguistics about modality.

I am proposing a semantics for function that follows the Kratzer model for the modal verbs and auxiliaries. In Section 2 I argued for a particular understanding of function as a modalized structure of capacities, and in Section 4 below I will show how Kratzer’s formal semantics for ought and must can be applied to function. In this Section I set out the basic elements of Kratzer’s theory.

The semantics Kratzer proposes for modal sentences with words such as can, may, ought, must (and supposed to, required to, obliged to, etc.) has three main elements: context dependence, possible worlds semantics, and a “that”-clause structure. I examine them in turn.

Context dependence Kratzer says that must and ought and can and might and the other deontic modal words (again setting aside the alethic modalities) are semantically incomplete and in use need to be supplemented by elements from context to enable the making of complete assertions. The apparent need for multiple senses, e.g., of ought, is on Kratzer’s view eliminated by additional contextual and speaker-provided meaning-elements to be understood as different from and additional to the meanings of the words; the lexical meaning of the word, of ought or must, is what is context-invariant. The removal of the need for many senses of ought – the bouletic, instrumental, legal, aesthetic, moral, epistemic; and similarly for must and can and may – is a major point in favor of Kratzer’s account. Being forced to postulate numerous senses of these words, as linguists and philosophers previously seemed required to do, is dubious practice. Ought as used in a sentence about moral matters seems like yet distinctly unlike ought used about some instrumental matter or some aesthetic matter; and then there is the epistemic or probability ought as in ‘He ought to be here soon’. There is obviously an underlying unity in the various uses, yet at the same time significant difference. Any adequate account must explain both the unity and the difference. Kratzer’s does both, whereas the “multiple senses of the word” account explains only the difference, not the unity.

Here are some examples of the differences. All of the following sentences are proper in English; their philosophical status is usually not as obvious as their linguistic propriety, however:

6a) You ought to do the morally good (right, best) thing

 b) You must do the morally obligatory (right, correct) thing (And you ought to do it, too)

 c) You ought to obey the law; legally you must obey the law

 d) You ought to choose the best means to your ends (Not: You must choose the best means to your ends)

 e) You ought to find that Bach is musically more significant that Monteverdi (Not: ‘You must find that Bach is…..’ except as a kind of emphasis)

 f) You ought to choose the chocolate bread pudding (since you like chocolate so much)

 g) You ought to believe what there is good evidence for; you must believe what there is certain evidence for

 h) John ought to be here by now, he left home an hour ago

Kratzer says that despite appearances the words ought and must are univocal in 6a) - h) above and that the semantic differences come from additional semantic content provided in some way by context. Thus Kratzer’s is a unifying and a simplifying account. She still needs to tell us how “context” accomplishes all this, but that is coming.

Invoking context to supply additional semantic information is, however, a tricky matter. The standard thing to say about context-dependence acknowledges Kaplan (1978, 1989) for indexicals and Grice for conversational implicature and for speaker’s meaning (Grice ‘Meaning’ 1957, ‘Logic and Conversation’ 1967; both reprinted in Grice 1989). Actually displaying how these mechanisms are implemented in specific linguistic situations requires considerable care and ingenuity in argument. Dowell (2011, 2012, 2013, 2016) is especially insightful and useful here.

Possible worlds semantics The second main element in Kratzer’s theory is that the semantics of the deontic modals, and by this she means their truth-conditions, are to be represented as quantifications over possible worlds. That in some sense “possibilities” need to be invoked to explain modals seems inevitable; they are about possibilities, after all. Kratzer’s approach uses universal quantifications for must and have to and ought and should and supposed to and others like them, and we may think of these as examples of a practical necessity, as Kratzer calls it, to distinguish it from alethic necessity. She uses existential quantifications for can and may and might to link with permission or possibility. Thus Kratzer says that ought-p is true iff p is true in some subset of all possible worlds. This seems very plausible, but the key issue will be how to identify the right subset.

In her semantics it is something in the context of utterance – sometimes speakers’ intentions, sometimes demonstratives, or etc. – that establishes a set of assumptions that are to be presumed to obtain in the situation. There will be both factual and normative components. She calls these together the conversational background. The factual component is the set of circumstances in which or against which the truth of the statement is to be evaluated.[[8]](#endnote-8) The set of propositions that makes up the factual component selects a set of possible worlds that she calls the modal base and symbolizes it as f(w). The conversational background also includes information about the rules or norms or values or standards (norms or rules or values for deontic modals and standards for epistemic modals) that are carried in the conversational background and are to be taken as applying in the instance. She calls the evaluative material the ordering source and symbolizes it as g.

For ought, the ordering source, that is to say the norm or value that is invoked, orders the worlds of the modal base in a ‘better than’ ordering, e.g., ordered as morally better than, aesthetically better than, instrumentally better than, more likely than for the epistemic, and so on. Then “best” in the statement of the truth-conditions selects, e.g., the morally best worlds as the set relevant to the truth-conditions of the sentence in question.

There is still a lot that is puzzling about how the normative standards being invoked act to generate a betterness-ranking of the worlds of the base. The use of best in particular is an issue. Not all legitimate uses of ought seem clearly to link to best, some seem to link to good, as in good enough, as the evaluative. I will discuss that issue in a later Section where I will argue that indeed good enough is the correct evaluative for ought.[[9]](#endnote-9) And I will argue also that in addition to the evaluative good (good enough on the better/worse scale) we need the evaluative right/not-right. I argue that must (and have to and required to and obligated to, etc.,) links with right or correct as its paired evaluative, while ought and should and supposed to link with better/worse as their paired evaluative.

The that-clause structure The third element of Kratzer’s semantics is that sentences using the modal words are to be understood, for semantic purposes, as all involving that-clauses, so that

 It ought to be that (a is P)

is the semantically relevant form and not

 a ought to do or be P

and similarly for must and can and might and so on. The embedded that-clause is always to be taken in the simple indicative sense. This structure makes ought and the other deontic modal words something like operators on propositions, as in the sentence ‘Ought-p’. In the literature, p is called the prejacent proposition, and I will use that terminology.

What this structure indicates is that, in its contribution to the meaning of the whole, the modality of the prejacent proposition is being altered by the ought; and that, and not some supposed ought-relation being predicated between a and P, is what is going on in the sentence. The ‘p’ itself is not modal, it is simple indicative, but the effect of embedding it inside a modal operator is to yield a modal understanding of it as part of the whole sentence. However, we can think of the ‘a ought to do P’ form as the de re meaning, in which we mean to say something like ‘It is true of the person a that it ought to be the case that they do P.’ This is not the same as the pure relational form, but it will do some of what the pure form does. Still, ought now means something different from what it would have meant in the relational form.

My final comment regarding this new linguistic approach to the non-alethic modals is a caution that a great deal about it is still in flux. If the basic idea is clear and compelling, there are many different possible implementations of that basic idea and there are serious puzzles still unresolved. We shall have to wait to see which turn out to be the best approaches overall. Luckily for my argument, function seems linguistically to be an easy case, even if the philosophy of it is complicated.

3.2 Kratzer on must and ought

On must

In an early paper, Kratzer (1977; reprinted in 2012, 4-20) says of must, as in

 I must go to the store

that it seems to be like an expression of the necessity of a deduction from suppressed premises, and so necessary relative to those premises; and indeed in that paper she offers a premise semantics that she models in terms of a possible worlds semantics. She explains the three elements of her theory, the context-dependence, the that-clause structure, and the possible worlds semantics, but she explains the semantics in terms of the entailment of the prejacent ‘p’ of the ‘must-p’ from that set of suppressed premises. The conversational base is the presupposition-set, which is the set of suppressed premises provided by conversational implication. It is the set of propositions that identify the set of possible worlds in which the prejacent is said to be true together with the normative premises, and together they entail the truth of the prejacent. Looking ahead to terminology she introduces later, we may call that set of worlds the modal base, and symbolize it by f(w):

 Must-p is true iff p is true at all the f(w) worlds, i.e., the worlds of the modal base

So must-p will be true iff p is entailed by the set of propositions that are true in the modal base.

I don’t think a premise-semantics will work for must. Let us suppose the following, which I will call the EGGS example:

I’ve decided I want eggs for breakfast and since we have no eggs in the house, it appears I must go to the store. What I actually say to my wife is ‘I must go to the store to buy eggs’ and since we have been assessing our wants and the contents of the refrigerator, and since we have been conducting this discussion and assessment together, we both know the facts and know the other knows, so the contextually implied and assumed body of information in relation to which my statement is to be interpreted is common knowledge between us.

On Kratzer’s theory cast as a premise semantics, the force of the must-statement derives from the logical relations embedded in the contextually implied body of facts, preferences and goals expressed in the premise-set. The force of the must arises because, in light of the assumed truth of that body of common knowledge of both facts and preferences, I am required to go to the store on threat of logical incoherence within my belief-and-value structure. But notice we have now lost the ability to distinguish, e.g., a moral ought from a prudential one: they are both just about maintaining coherence. Something has gone wrong.

Kratzer replaces her first attempt with something considerably more sophisticated in the next theory she offers. In ‘The Notional Category of Modality’ (Kratzer 1981, reprinted in Kratzer 2012) she introduces a practical necessity (symbolized ‘Nec’) that encompasses but does not distinguish must from ought or from have to or required to or should or supposed to. This practical necessity is as it were the generic kind, and the speciation is yet to come. The criteria of speciation have become a much-discussed issue – this is the must vs. ought problem, the strong vs. weak necessity issue – and the matter is still unsettled. I will have something to say about it later but for now I want to stay with the generic concept.

The new theory of practical necessity introduces ordering as an element in addition to the factual background of the modal base, and thus allows considerably more flexibility. It works this way. The possible world or worlds in which the prejacent is to be true is selected first by being contained in the f(w) set of worlds which are those selected by the factual background, and then secondly by the ordering source, which orders the worlds of f(w) into a better-than ordering based on the norm or evaluative in the ordering source. And last, the semantic formula selects the best of the f(w) so ordered, meaning the highest-ranked of the f(w), to yield the following:

 Nec-p is true at the world of evaluation iff p is true at the best of the f(w) as ordered by the ordering source

It seems to me plausible that there are in fact only two core semantic constructions here, both based on Kratzer’s proposal for Nec. One will be the must-group and the other the ought-group, with the remaining deontic modals, e.g., required to and have to, and should and supposed to, explained as belonging to one or the other of the groups but with small variations on the theme. (This idea is implicit in Bjornsson and Shanklin 2014. I discuss their proposal below.) Explaining these variations is also something that remains to be done. But if I am right, explaining the difference between must and ought is one of the big challenges to making effective use of Kratzer’s definition of the generic Nec-p. I will offer a treatment of must and ought below, which I claim distinguishes them properly.

On Ought

As I said, I will shortly make a proposal about distinguishing ought from must, but I need to develop some more background before I do.

The truth-conditions Kratzer gives for the generic ought statement follow those for generic Nec:

 Ought-p is true iff p is true at all the best worlds of the f(w) worlds as ordered by the norm or norms in the ordering source

These proposed truth-conditions seem to fit as applied to ought and in part this appears to be because ought registers the requirement to do the better thing as the thing with more value. The truth-condition makes sense, because the best worlds of the base will be the worlds where most deontic value will be generated. Chrisman (2015, 86) in his book on the subject, expresses the semantic rule for ought this way:

ought is the unary function from a proposition that gives the semantic value true just in case the proposition is true in all of the worlds of the modal base for which there is no higher-ranked world according to the ordering source

Elsewhere he says, usefully, that what the Kratzer formulation does is to divide up in an illuminating way the elements that go into the accessibility relation. Here is what he means by that. In standard possible worlds semantics, for some generic necessity operator N, one says something like:

 N-p is true at the world of evaluation iff p is true at all the worlds accessible from the world of evaluation

and what Kratzer does with her formulation using both the modal base and the ordering source, is to open up the accessibility relation to display its elements so that we can select and adjust them to fit the needs – the “meaning” – of the particular modal operator we want to understand and model. It gives her the ability to fine-tune accessibility relations to fit the needs of her semantics. She distinguishes the factual circumstances from the ordering source (the factual from the normative element), and uses both to craft the precise accessibility relation she needs.

To help us understand this, let us consider ought in a practical example. I use the EGGS example that we saw previously. The example sentence is

 You ought to go to the store and buy eggs

said by the wife to the husband, and the situation, as before, is a husband and wife considering the state of their refrigerator, what they would like to eat for breakfast, and what they should do given those facts and their wishes and other relevant constraints and considerations. The conversational background will contain the relevant information about the context of utterance and the situation they are in, especially including the couple’s preferences, the contents of the refrigerator, the relative nearness to the store and etc.

A question: do all potentially ordering norms – those about preferences or ends or norms or whatever is broadly normative – go in the ordering source? Or do some of them, the constraint preferences, as we might call them, go in the base, leaving only the operative norm or goal or preference, the one driving the decision, to go into the ordering source? No, they all have to go in the ordering source because we have to balance them off against one another based on their relative importance, even though only one is the “motivating” value. They aren’t merely constraints, they have varying importances and we must take that into account. So the ordering source will contain all preferences, norms and values, but somehow calling out breakfast as motivating. In this case it will be the ranking of what is the (non-morally) better thing to do overall, mixing likes and dislikes and goals and some moral norms acting as constraints (no stealing); and we need but don’t have a formal way to register the difference between the motivating norm and the constraint-norms. And of course the factual element will include all the non-normative facts about time and distance and what is practical and achievable and at what cost in effort and time.[[10]](#endnote-10) [[11]](#endnote-11)

The truth conditions will in general be as follows (retaining best for the moment):

 Ought(p = they go to the store to buy eggs) is true iff they go to the store at all the best worlds of the modal base as ranked by the ordering source

This seems clear, and seems to work naturally and intuitively for ought. A very common thing to say about the nature of ought is that we ought to do the best we can, and Kratzer’s formulation gives us that. However, we still need more clarity and detail, and a technically more thorough definition. I introduce the technical material after taking up the good enough vs. best question.

Best vs. good enough

I said that I thought that if some world is ranked as good enough – not best, just good enough – that that could make an ought-statement true. (Note that good is not the same as good enough; good is to my ear a higher ranking than (just) good enough. Both are contextually established on a better/worse scale.) There are several reasons to think this to be so. First, there is the “degree of ought-ness” argument, then the misleading or misplaced uniqueness best brings about, and lastly, the “prima facie ought” argument.

For the first, consider Sartre’s well-used example, in a variant phrasing:

 You ought more to stay home to care for your aged mother than (you ought) to join the resistance

If this is a proper sentence in English, and it certainly seems to be, it suggests that oughts come in greater or lesser degrees of demandingness. And if that is true, if, in our example both those ought-statements are true, as they appear to be and as they have to be if the sentence is to make sense, then best cannot be the correct evaluative word and rather good enough is. Lassiter (2011 and elsewhere) generally argues for a scalable ought, and he presents a number of examples like the above.

The next consideration is that using best forces the interpretation “best everything considered” to yield the unique thing that one ought to do. That is attractive: one can say ‘We ought to do the best we can’ and feel we are saying something both profound and sensible, not an easy thing to do. But notice that we can equally as well say ‘We ought to do all we can of things that are worth doing’ and that also sounds both profound and sensible. So one can come to feel that the uniqueness induced by best is artificial, and is certainly misleading, and so not to be made the basis of a semantics for ought. For suppose one is in a situation where if you use good enough, you derive two oughts, an ought-p and an ought-q, and while one may be more demanding than the other, it is possible to do both. Should you not do both? Yet if you use the formula with best, you will be told to do only the better one, and fail to be told also to do the lesser, although you could have. But, a critic can answer, you should have evaluated p&q and p&q&r and so on, for all actions that do not conflict. Then best works right. True, but why not just use good enough? Why should you have to consider all combinations of the non-conflicting possibilities to get to an answer?

The final point concerns the usefulness of talk like ‘you ought prima facie to do p, and prima facie to do q’ and then on further reflection concludes that since they do conflict and you can only do one, you should do p as the more important. Using best blocks the prima facie ought-claim, while with good enough, you can generate the complete set of candidate-oughts, prima facie oughts, and then decide which of them is more demanding, and which you can do. This is not a separate argument, rather an observation about usefulness.

The last argument on the topic of good enough, is that with it there is some point, some level of deontic value, at and above which ought-p is true, and below which it is false. But that means that an ought-p with deontic value below the critical level is false; yet the formula using best has ought-p being true no matter what deontic value it has but only so long as it is best. I think this is not a true account of ought.

3.3 Kratzer on practical necessity, the technical material

I want now to examine the technical definition Kratzer offers for practical necessity because the details matter, and the details give us something quite specific to key our discussion to. I will use this material again when I set out a semantics for function-sentences.

Here is what she says about practical necessity (Kratzer 1981; 2012, 40 – the material occurs first in 1981 but I use the reprinted and amended version of 2012 as the more current). I will first present her semantics using best, and then present an alternative formulation using good enough.

Kratzer on necessity

Necessity

A proposition p is a necessity in w with respect to f and g iff for all u ∈ ∩f(w), there is a v∈ ∩f(w) such that

1. v ≤g(w) u

and

1. for all z ∈ ∩f(w): if z ≤g(w) v, then z ∈ p.

The f and g elements are the factual elements of the conversational background and the normative elements of the conversational background, respectively. f is a set of propositions, those that are conversationally implied by the speaker as true. We are to understand that a proposition p is to be identified with the set of possible worlds in which it is true. Thus ∩f(w) is to be interpreted as the intersection of the sets of worlds represented by each of the propositions. And that in turn yields the set of worlds in which all the propositions of f are true; ∩f(w) is that set and she calls it the modal base.

About this definition she says:

Simplifying slightly, a proposition is a necessity just in case it is true at all accessible worlds that come closest to the ideal determined by the ordering source

Here is what this means. As before, f is the factual background and so ∩f(w) are the worlds of the modal base, i.e. the worlds in which the propositions of the factual background are all true; and g is the normative element or elements, rule or norm or value, carried in the ordering source. The ordering source gives us ‘v ≤g(w) u’ which means that world v is as good as or better than world u, with respect to the ordering established by the ordering source g.

Thus a proposition p is a necessity, at the world of evaluation w, with respect to f and g, iff for any world u that is among the worlds of the modal base f(w), there is a world v also contained in the modal base such that v ≤g(w) u; and for all z contained in the modal base, if z is as good as or better than v, then z is contained in (the set of possible worlds which is) p.

Now we need to move to the ordering source, where we will learn how to derive and understand ‘v ≤g(w) u’. Here is what Kratzer (2012, 39) says about ordering:

 Inducing the ordering ≤A

For all worlds w and z ∈W: w ≤A z iff {p: p ∈ A and z ∈ p} ⊆ {p: p ∈ A and w ∈ p}.

About this definition she says (2012, 39):

According to this definition, a world w is at least as close to an ideal or norm determined by a set of propositions A as a world z iff all propositions of A that are true in z are true in w as well. The relation ≤A is reflexive and transitive, but not necessarily connected. Technically, ≤A is a partial preorder, then. It is partial because worlds don’t have to be comparable, and it is a preorder because it is not necessarily antisymmetric.

Put in considerably more informal terms, what this definition of ordering does is the following. The set A of propositions identifies the set of norm-complying states of affairs in the worlds of f(w); which is to say, the instances of norm-compliance in f(w). As an example, think of it in terms of a simple set of laws, with the sole elements “Do not do B-things and do not do C-things.” Then the set A will be all the instances in the worlds of f(w) of ‘no B-things done’ and ‘no C-things done’.[[12]](#endnote-12)

Kratzer uses the set A of propositions to order the worlds as follows: a) there is equivalence in betterness-ranking between worlds when they contain the same propositions from A, b) one world is better than another when the better world contains one or more of the propositions of A that the lesser world does not, and c) the worlds are incomparable when each contains different propositions from A.[[13]](#endnote-13) Portner (2009, 63-64) provides a useful detailed discussion of how Kratzer’s ordering works.

And for Necessity with good enough

A proposition p is a necessity in w with respect to f and g iff for all u ∈ ∩f(w), there is a v∈ ∩f(w) such that

1. v ≤g(w) u

and

1. for all z ∈ ∩f(w): if z ≤g(w) V, then z ∈ p.

The f and g elements are the factual elements of the conversational background and the normative elements in the conversational background, respectively. The v, u, z and V are possible worlds of the ranking, the lower-case letters acting as variables and the upper-case V as a name. Worlds as good as or better than V (ranked as high or higher than V) support a true ought-statement, those less good do not. The location of V on the scale of betterness is a contextually determined matter.

And so:

Simplifying slightly, a proposition is a necessity just in case it is true in all accessible worlds that come close enough to the ideal determined by the ordering source

3.5 Must and right and ought and good

I want to emphasize, again, how compelling Kratzer’s intuitive and pre-technical account of must/ought is. That seems to be a firm base and beginning, something we want to preserve, even though her theory as she elaborates it has significant issues. And her formal treatment, above, has a number of attractive features. But I say must/ought because in light of her formal treatment as I’ve sketched it above, she has no theoretical means to differentiate the two basic kinds of deontic modals; for must/have to/obligated to/to be required to seem to go together, and ought/should/supposed to seem to form a second group. How these two groups are to be distinguished is still unclear, and while there are a number of proposals in the literature, no one is obviously correct. I will shortly suggest a way to differentiate must from ought which I think has considerable promise, but time and further investigation will decide. (But see for instance Silk (2012a and 2012b for a very different approach. I will criticize his approach and defend my own below.)

As I have argued, the force of the deontic must derives (must derive) from the deontic norm that grounds it. What one must do is what is deontically obligatory, and failing to do what is deontically obligatory is deontically forbidden. And that is why must-p is inconsistent with not-p: must/must not, obligatory/forbidden are yes/no sortings that have no middle ground, no more/less. And must when it is true sorts the prejacent into the right/obligatory/required group. For ought, by comparison, the norm yields deontic expressions of what it is deontically better to do, that is to say what is good enough or better or best to do. This much, right/not-right as a yes/no categorization, contrasted with good/better/best as a more/less ranking, seems intuitive. It seems to capture something natural about the difference between the words. Bjornnsson and Shanklin (2014) suggest that this contrast – between yes/no and more/less – is central to understanding the difference between must and ought. I think they are right, and I take that up below,

But before I do, I ask whether we can consider yes/no, right/not-right, correct/incorrect as fully parallel to better/best? Are right/not-right and correct/incorrect evaluatives, that is to say, in the same way that better/best is?

Right/not-right, correct/incorrect Everyone feels comfortable that better/worse is an evaluative: it generates an ordering, a ranking, an “evaluation.” But how can right/not-right be an ordering? one can ask, puzzled because right/not-right doesn’t fit on a scale, it is just a matter of yes/no. I will argue that it is an evaluative also, and that better/worse and right/not-right (correct/incorrect) are the two key evaluatives.

There is a history of allowing that better/worse is evaluative and denying that right/not-right is evaluative; of holding rather that right is a normative, presumably a sort of deontic modal term like ought and must. Wedgwood (2009) develops this idea; others do also. The problem with the view is that these examples seem so clear-cut:

1. The right/correct answer to that trigonometry problem is …
2. The right/correct financing choice is … (with the others you end up owing more that the car is worth)
3. The right/correct action to choose is … (it is obligatory in the circumstances; or, it is uniquely the best thing in the circumstances)
4. The right/correct action is … (it is legally mandated in your circumstances)

Here right or correct is qualifying something in the typically evaluative way; in just the same way we use better/worse as an evaluative to say one thing is better than another. And it seems also that right used as an evaluative implies there is a reason for the rightness evaluation, just as does ‘better/best’, and that that substantive reason, whether moral, legal, or etc., can also be indicated by ‘right’. So ‘right’ seems to have both uses, the evaluative use as seen above, and what could be called the normative use. Judith Thomson contrasts the uses as “evaluative” vs. “directive” (Thomson 2008) – good is evaluative, must and ought directive. She reserves normative for the whole range of deontic subject matter. This seems a usefully intuitive pair of terms.

Those who hold that right has no evaluative use must simply deny that i) through iv) above are proper in English, or they must reinterpret them as directive uses throughout. But either of these alternatives is distinctly uncomfortable. Much better to allow that there are two uses, the evaluative and the normative or directive. And there are two uses for ‘better/worse’ also, it is not used only as evaluative. To see that you need to couch it as about good: ‘good/better/best’ is evaluative but ‘the good’ is potentially directive. We know we cannot do without ‘good/better/best’ as an evaluative, so the right (the correct) thing to do is to recognize two uses of both ‘right’ and ‘good’.

The confusion is exacerbated because while both better/worse and right/not-right are evaluatives, better/worse is the binary relation ‘x is better than y’ and thus potentially can form orderings, while right/not-right is an unary relation and cannot form orderings. It can form sortings into the right and not-right groups, however, and an ordering is a particular kind of sorting. Only binary relations are candidates for generating orderings, of course, but all properties, unary, binary, trinary and higher, certainly generate sortings. (I will henceforth use ‘ordering’ to indicate sortings that are rankings, and ‘sorting’ to indicate the more general sort of ordering that all n-ary relations can achieve.)

Better/worse generates an ordering that may be either a partial or a total ordering. Any better/worse value that is ranked is located as better or worse relative to other better/worse values. But not all values need be ranked: better/worse does not necessarily produce a total ordering on a particular domain because some elements of some domains may not be sorted by the particular ordering relation you happen to be using, and those elements are simply excluded from the ordering. Further, some normative rules require more order that others. Simple preference-orderings typically are partial orderings, while act-utilitarianism requires a total and cardinal-isomorphic ordering because that moral theory holds that its theoretical concept of utility is metricizable and that every act and circumstance can be assigned a quantitative measure of its utility.

So I hold that rightness is an evaluative property that induces a sorting that assigns the things evaluated to the right or the not-right groups. This is most intuitive in the case of laws: the values are legal and not-legal and there is no more/less element. Right and its parallel yes/no evaluative correct can model any evaluative that takes yes/no values. And better/worse is an evaluative that can model binary relations that incorporate some scalable or semi-scalable property and so can generate orderings.

An ordering source for must

Now let’s see if we can find an ordering source treatment for must that gets the norm in the ordering source and respects the yes/no character of the sort of evaluative and norm required by must. If we can do that, we could use the best formulation of truth-conditions from Kratzer’s definition of Nec to find the right worlds since right will trivially be best. But I think it is preferable to reformulate the definition of Nec so that in must-p, the evaluative best no longer appears and we use ‘right/correct’. That will make the force of the must derive from the norm in the ordering source and at the same time be reflected in the rightness-condition in the decision rule.

As I said when I first introduced their ideas, Bjornsson and Shanklin (2014)[[14]](#endnote-14) argue that in ordinary talk must aligns with yes/no contrasts and ought with more/less contrasts. Thus for all the deontics, e.g., moral, legal, aesthetic, teleological, bouletic and etc., must will take the generic evaluative right/not-right; or, less generically, right/not-right for the moral, legal/illegal for law, and right/not-right again or correct/not-correct for the instrumental and bouletic. By contrast, ought aligns with the more/less ordering of better-than. Thus ought aligns with the generic deontic value good in good/better/best, and must with the generic deontic value right. In epistemic contexts must aligns with certain/uncertain and ought with more/less likely. In instrumental and bouletic contexts we use must when there is only one choice that is at all acceptable, i.e. correct or right, otherwise ought. Legal contexts are yes/no in nature because the evaluative is legal/illegal and so they take only right/not-right. Moral contexts make full use of both evaluatives and there appear to be two distinct (but, we must presume, related) dimensions of evaluation, better/worse and right/not-right.

Thus my hypothesis is that the conversationally implicated norm in the ordering source for must always takes yes/no values of some kind appropriate to the type of must. So consider this for deontic must and ought:

 Must-p is true at the world of evaluation iff p is true at all the worlds of the modal base which the ordering source evaluates as realizing the deontic value right or correct

And more crisply

 Must-p is true iff p is true at all the “right” worlds of the modal base

And so then for ought we have:

 Ought-p is true iff p is true at all the worlds of the modal base which the ordering source evaluates as realizing a large enough deontic value of goodness

and more crisply, again:

 Ought-p is true iff p is true at all the “good enough” worlds of the modal base

For must, this treatment provides for both the truth of p, the rightness of p and the wrongness of not-p in the “right” worlds of the base, since if p is right, as it will be in all the “right” worlds, then not-p is not-right. And similarly for ought, it provides for the truth of p and the “good enough” deontic ranking of p in the worlds of the base, and the possibility that not-p is true in the not-good-enough worlds of the base.

Adapting Kratzer’s technical definition to right/not-right:

What I am proposing is the we differentiate the generic necessity of Kratzer’s technical definition into a definition for ought that uses the better/worse ranking of worlds, and for must that uses the right/not-right sorting of worlds.

We have already seen the Nec-definition appropriate to ought. Here is the Nec-definition, as adapted to must using a right/not-right evaluative:

 M-p is true with respect to f and g iff

 for all u ∈ ∩f(w), u ∈ Rg(w) or u ∈ not-Rg(w)

 and

 for all z ∈ ∩f(w): if z ∈ Rg(w) then z ∈ p.

What this says is, first, that all worlds are sorted as “right’ or “not right” with respect to g, and second, that M-p is true iff p is true at all the Rg(w) worlds, i.e., the “right” worlds with respect to the rule or norm in g. I am of course using Rg(w) as the unary “right” relation counterpart of thev ≤g(w) u “better than” binary relation. Both of them are sortings of worlds, and those sortings are based on parallel ‘right’ and ‘better than’ evaluatives that apply to acts and states of affairs.

But we need still to relate Rformally to the norm, to show, that is to say, how the RA sorting is induced.

 Inducing the RA sorting:

 For all worlds w ∈W: w ∈ RA iff w ∈ {p : p ∈ A}

The A-list of propositions is the set of propositions that is generated by applying g, which is the relevant rule, norm or value, to the f(w). The set A lists the instances of right states of affairs that obtain in the worlds of f(w), as derived by applying the g to those worlds. Notice that Rg(w) is a property of worlds, just as the binary relation v ≤g(w) u relates pairs of worlds, whereas the set A lists g-complying instances at worlds, i.e., instances of right conditions or outcomes. Locating the p : p∈A locates the propositions that record the instantiations of the norm and so display the rightness realized at the worlds, which is to say, the fact that they realize the deontic value rightness. And what Rg(w) means is not that the g(w) worlds are right (they are “right”), but that the deontic value of rightness as applied to courses of action or outcomes is realized at them.

What we are concerned to do formally is to indicate the relationships among (1) the rule or norm or value invoked by the g, (2) the set A generated by applying the rule or norm or value to the f(w), and (3) the evaluative result which is the better-than ranking or the right/not-right sorting. We report the better-than ordering as the ≤A ordering, and the right/not-right sorting as the RA sorting. This gives a technical definition of must that parallels Kratzer’s definition for ought. It tells us that Must-p is true iff p is true at all the “right” worlds of f(w), and that is the result we wanted.

Must/ought and strong vs. weak necessity

Must is typically said to express a strong necessity and ought a weak necessity, for consider:

7a) Must-p implies ought-p

 b) You must do the right thing, and of course that’s what you ought to do too

but the reverse does not hold, so that you can say

 c) I really ought to do it, but it’s not something I must do (after all, it’s good but it’s not an obligation)

In d) below, by contrast, the # indicates something gone wrong

 d) #You ought to be helpful and courteous and therefore that’s what you must do

but the reverse is true:

 e) You must obey the rules and therefore you ought to, too

We have seen this illustrated humorously but to the point in the sentence

 f) Employees must wash their hands; everyone else really ought to

This fits with reasoning in standard moral theory as well: must links with duty, and ought links with what promotes the good. Sometimes the practice of using ought to express obligation obscures this difference, but I think if we press the matter, we end up clarifying the contrast by going to must to convey strict obligation and duty, and ought to convey the pressure to bring about the good. Kratzer’s theory needs to explain the above patterns if it is to be fully satisfactory as a semantic theory for must and ought, yet as it stands, with only the undifferentiated Nec, it cannot do that.

Before I move on to my own suggested solution to the strong/weak *must/ought* issue, I need to comment that others take different approaches from mine. See Portner and Rubinstein (2016), von Fintel and Iatridou (2008) and Kolodny and MacFarlane (2010) among many others for interesting work on the topic. Portner and Rubinstein are especially interesting because they get almost to the right/not-right contrast, but then back away from it and treat it as a variant of the better/worse case. I won’t discuss these approaches here and will take up the necessary exercise in criticism and comparison at some other time.

But I need to acknowledge that Alex Silk (2012a, 44, and 2012b) diagnoses the strong/weak problem very differently. See also his (2014) for further discussion. In his (2012a) he makes an argument in exactly the opposite direction from mine, and I need to say why I think he is wrong. He offers these examples:

8a) I should help the poor. In fact, I must.

 b) I must help the poor. #In fact I should.

 c) I should help the poor but I don’t have to.

 d) #I must help the poor, but it’s not as if I should.

He marks what he takes to be the incorrect or inapt expression with the ‘#’ symbol.

In 8a) he offers as apt a sentence that seems to suggest that should implies must. But it does not, and the appearance is an artifact of his use of the ‘in fact’ locution, for consider ‘I should help the poor and therefore I must’ which rates a #. What the ‘in fact’ is doing is precisely to disclaim that otherwise improper suggestion of entailment.

In 8b) he seems to be denying that must implies ought/should, but there the problem again is that the ‘in fact’ locution is being misused, as we can see if we take it out: “I must help the poor and so I should’ is unexceptionable. I think b) is anomalous because the ‘in fact’ phrase suggests some added emphasis, but what comes instead is the ‘should’ which is weaker. It is a pragmatic, a conversational infelicity to say the stronger and then add the weaker as if it were something even stronger.

In 8c) something more complicated is happening. I think it rates an # but for reasons not related to strong/weak. The entailment from should to must is being correctly denied, but we are still unhappy. I think that is because both ‘I should help the poor’ and ‘I must help the poor’ are generally felt to be true. I think our unhappiness with 8c) arises because it is affirming something we think is false, namely that we don’t have to help the poor. ‘Should’ doesn’t entail ‘have to’, but when both parts of ‘p but q’ are things we know to be true, we will not hear c) as the denial of an entailment, but rather as the affirmation of a falsehood.

And in 8d) Silk is right that the # is warranted and that is just because ‘must’ entails ‘should’.

We need examples that aren’t so ambiguous about the source of the ‘#’ condition. Typically one says ‘We must help the poor’ or ‘we should help the poor’ but then denies any obligation, stemming just from that, to help any particular poor person on any particular occasion. Additional circumstantial facts are needed before we can derive either ‘We must help this person’ or ‘We should help this person’. I hold that ‘We must help the poor’ is apt and true, ‘We should help the poor’ is apt and true, and ‘We must help the poor and so we should’ is apt and true. But ‘We should help the poor and so we must’ is inapt and rates a #. Consider ‘I should exercise today but I don’t have to’ and ‘I must exercise adequately and I should (but not necessarily today)’. Both of them are apt, depending on circumstances. The requirement is to exercise adequately, not to perform any particular instance of exercising. But ‘I should exercise adequately and so I must’ rates a #.

We can find other examples where the must to should inference seems fine, such as e), f) and g) below.

 e) I say ‘We must come to that person’s aid’ and you say ‘Of course we should, it’s the morally good thing to do’

f) I say ‘We must help the poor’ and you say ‘A person should help the poor generously and to the limit of a proper sense of what is due’

g) I say ‘We must help the poor’ and you say ‘And we ought to begin by helping that man there’

In my examples, I have of course tried to shape my intended readings by couching the wording in certain ways. In e) I have the ‘should’ being used to affirm the duty, thus removing the unhappy suggestion of the weaker being used to replace the stronger, but rather to affirm or elucidate. In f) and g) I have shaped the examples as the classic case of ‘must’ stating a duty to do a kind of thing (help the poor) and the ‘ought’ or ‘should’ being used to provide urgency or to recommend a specific implementation.

Strong/weak, must/ought and right/good Finally, I want to suggest that the Bjornsson and Shanklin (2014) ‘yes/no vs. more/less’ idea, which is to say the ‘right’ vs ‘better-than’ contrast, will explain the strong/weak necessity phenomenon. The answer lies in the clear-cut correctness of 9a) and b) below:

9a) If it is the right thing to do it is a good thing to do

 b) It can be a good thing to do, but not necessarily be the right thing to do (it may be good but not be required as a duty, or some other, conflicting thing may be required as a duty)

Here are some examples:

 c) It is always morally good to be polite but it is usually not demanded by what’s right (it’s not something you must do)

 d) It is the right thing to do to support and protect one’s spouse and one’s children, one morally must do that; and of course that is always a good thing to do, too

The point here is the general one, that good aligns with moral requirements of value enhancement but not duty and obligation, whereas right aligns with moral requirements of duty and obligation. And if that is correct, then the underlying relations between the evaluatives explains the resulting relations among the ought- and must-sentences.

For these reasons, I think that Bjornsson and Shanklin are right about the yes/no vs. more/less issue, and I think that is what differentiates must from ought, and explains the strong/weak contrast. As always, however, we shall have to wait for comment and criticism to develop before we can feel certain.

3.6 Supposed to and ought

Finally, what about supposed to? I need to understand it if I am to make an argument linking supposed to and functions to.

I will begin by comparing and contrasting supposed to and ought. They are similar in that they are both modals of weak necessity. (There is also should, which I take, at least for now, to be the same as ought.) Both ought and supposed to fit with agents or non-agents as subjects, as in

10a) the world ought to be a better place

we can say, and

 b) the clock is supposed to strike at 12

But there are differences. You can say

 c) I’m supposed to add the spices in two steps but I’m not sure it matters

which seems fine, but d) looks odd:

 d) #I ought to add the spices in two steps but I’m not sure it matters

which seems to rate the # because adding the ‘not sure it matters’ seems to deny the force of the ought. But note that in the interest of speed you can accept a lesser outcome and yet not deny the ought:

 e) I ought to add the spices in two steps, the result will be better, but I’m in a hurry, I’ll accept second-best

When you say supposed to you seem able to disavow the recipe’s authority whereas you can’t do that with ought, you have to agree to take the less desirable consequence. Or this:

 f) ‘As a poet I’m supposed to think poetic thoughts’ my friend says, ‘but that’s bullshit’ he adds

 g) #‘As a poet I ought to think poetic thoughts’ my friend says, ‘but that’s bullshit’ he adds

Now, you could deny that this is a genuine instance, claim that he is speaking ironically, that the word poetic in what he says should be heard with scare-quotes. But maybe it’s not, because maybe he’s railing against the currently prevailing view in some quarters that poetry must be “poetic”. That’s not ironic, that’s invoking a received standard (supposed to be poetic) and denying it.

And he can do that with supposed to but not with ought. You just can’t do that with ought without being ironic or paradoxical throughout, yet with supposed to, you can say the sentence and mean it literally. You can say

 h) I’m supposed to add three teaspoons of thyme but I don’t think I ought; I think this recipe is unbalanced

Notice that – ‘I’m supposed to but I don’t think I ought’.

What is happening? I suggest it is this: in using supposed to you are invoking a standard or rule, acknowledging it is a standard or rule, identifying the thing to do given it, yet refusing to agree that that standard or rule is correct or appropriate or applicable and so refusing to affirm it; or if correct or authoritative in some sense (the recipe), for other reasons refusing to affirm it and be bound by it, which is to say refusing its claim to require and deserve obedience. In supposed to statements all the parts of the ought statement are there except your commitment to the norm. You are refusing to bind yourself, refusing the commitment to the norm that seems to be part of the meaning of ought-assertions. I think that is the key difference between supposed to and ought. And the fact that saying ought and then refusing to affirm it and be bound by it feels paradoxical seems to show that in judging and affirming that ought-p, one is indeed ‘binding the will’ as Kant says about the matter. For can you make the ought-judgement and not go on to form the (prima facie; defeasible) intention and disposition to do the thing? I don’t think you can. The example sentences seem to indicate that language-use, at least, doesn’t think you should try to, either.

So it seems that if you say the word ought but do not so judge, do not affirm the norm, you are using the word incorrectly and should really be saying supposed to. This is a different approach to the ‘normative judgement internalism’ issue (NJI) – the issue of whether, in judging ought, one binds oneself to the norm invoked. My suggestion locates the NJI in the lexical rule governing the use of ought. This can seem to trivialize the issue, but I think instead clarifies it: you can judge either ought or supposed to, depending on what you believe and whether you mean by so judging to bind yourself to the norm. The comparable contrast for must is more complicated. If you say must (in a deontic) you invoke the NJI and if you want to avoid that, you should rephrase your comment to something like “the rules say it is correct to do X” which leaves you uncommitted as to whether you agree. Consider these sentences, again with # marking the inapt or incorrect expression.

11a) #I ought to but it’s not the right thing to do

 b) I’m supposed to but it’s not the right thing to do

 d) #I ought to but I think I really ought not

 c) I’m supposed to but I think I really ought not

 e) I ought to but I’m just not going to (although I know I should)

 f) I’m supposed to but I’m just not going to (although I know I should)

 g) #I ought to but it just doesn’t matter to me

 h) I’m supposed to but it just doesn’t matter to me

 i) #I ought to but I just don’t feel any pressure to do it

 i) I’m supposed to but I just don’t feel any pressure to do it

These all reflect my judgements of apt/inapt, and others may feel differently. What is needed is a much broader survey of usages and examples than I’m prepared to provide here. Nonetheless, I think this is enough data certainly to be suggestive, and since it fits well with other theoretical and linguistic considerations, I will tentatively use it.

But can this be all there is to the long-standing quarrel about normative judgement internalism? No, it isn’t and I think there is much more yet to come. What is it about ought that makes the difference? And how does one “bind one’s will” by so judging? That, after all, is the truly puzzling part. But the first thing we needed was to see how language worked to allow us to signal that we were committing ourselves to the norm, and what the marker of that commitment was; and it is done by judging “ought”. That seems problematic only when you think of it as a question about what ought is doing for us, because what aspect of the meaning of the word could make that commitment for us? No aspect makes the commitment for us, it is just that we do not use the word correctly – and do not really make the ought-judgement, really judge only supposed to – if we use the word but do not also make the commitment.

Supposed to –technical material What will be the technical definition of supposed to? It will be just like ought except that the speaker’s implication of commitment to the norm will not be there. Is that an element of utterance meaning, either a lexical difference or a difference in what is contributed by context? Or is it a pragmatic difference? The words are different, so it is quite hard not to take it as a difference in lexical meaning. But if it is a difference in the utterance-meaning, do we need a semantic treatment different from Kratzer’s truth conditions for generic necessity? For where will we lodge the difference, if not in the possible worlds truth-conditions?

I suggest that perhaps we can handle the problem by supposing the lexical difference signals a difference in how the g, the norm, is being invoked. Can we say that for ought, the ranking is as the speaker judges best in light of the norm, and for supposed to, the ranking is as the norm ranks with the speaker being agnostic on the matter? Perhaps so. And if we can handle it that way, then supposed to is another variation on generic necessity. I think that must be true, but it seems too purely a linguistic matter for me to usefully attempt to deal with here, and I will pass over it. I do think the characteristics of supposed to are reasonably clear, however. But notice that this same problem will arise again with all the other deontic modals with their slight variations on the theme of generic deontic necessity. The power of Kratzer’s account of generic deontic necessity is compelling, but it remains something of an open question how the differences among must, ought, supposed to, have to, required to and all the others are to be recognized, while at the same time maintaining a firm hold on the strong underlying samenesses.

**4.0 Function is a deontic modal word**

4.1 Function as a modal word and concept

The Kratzerian schema

I want to begin this explanation by reviewing how I arrived at the conclusion that function is a deontic modal word. The standard Kratzerian schema for function, for given f and g values, would be:

 F-p is true at the world of evaluation iff p is true at all the good enough f-worlds as ordered by the g of the ordering source

This is correct but not revealing. To display all the needed semantic elements of function, we need the particular f- and g-values that make a function a function. Also, just as for ought vs. must, we need to differentiate the better/worse ranking types of function from the right/not-right, correct/incorrect types.

The schema, adapted

Type 1: Biology, chemical systems and agential cases where the enabling is “better/worse”

 F-p is true at the world of evaluation iff p is true at all the well-enough enabling C- structure worlds at which p = C1 and Ci enables Ci+1 well enough to fully enable Cn

The ordering source ranks worlds based on how relatively well the enabling is performed. The selected world or worlds of the truth-conditions are the worlds at which the Ci are well-enough enabled to fully enable Cn.

In terms of my standard example:

 F(p = the heart pumps the blood) is true iff p is true at all the C-structure worlds at which p=C1 and at which Ci is well-enough enabled to in turn well-enough enable Ci+1 … to in turn fully enable Cn where Cn = to maintain life

The various chemistry examples and the agential will work similarly.

Type 2: Physical law (fundamental physical law), where the enabling is “correctly”

 F-p is true at the world of evaluation iff p is true at all the correctly enabling C-structure worlds, that is, the worlds at which Ci correctly enables Ci+1 which correctly enables Cn

The C-structure tells what is to count as correctly enabling. E.g., if the C-structure is in or of Newtonian physics, correct enabling is enabling according to Newtonian physics.

So for the physics example:

 F(p = mass generates the gravitational force) is true iff p is true at all the correctly- enabling worlds of the indicated C-structure, i.e., the set of worlds in which mass correctly generates the gravitational field (=C1), and the action of the gravitational field on the masses (=C2) correctly enables the capacity for attractive force between the masses in magnitude F (=Cn), which is to say in all the Newtonian worlds.

Correctness is a yes/no matter at each Ci, and either Ci enables Ci+1 correctly according to Newtonian physics or it does not.

Type 3: Mathematical (logical, conceptual), where the enablement is “correctly”

 F-p is true at the world of evaluation iff p is true at all the correctly enabling C-structure worlds

The particular C-structure invoked by the f tells what counts as correct enablement and it will locate the mathematical objects, properties and functions being invoked in the particular case. As before, the mathematical factual base is the particular type of C-structure being invoked in the case, and the evaluative evaluates the type and quality of the enabling on the correct/incorrect dimension. The capacity being invoked will be the capacity of some particular mathematical function to yield the result it yields when correctly enabled, as I say, or when correctly saturated, as Frege says.

So for the function-statement ‘It is functionally the case that the function squaring takes one number as argument and yields as result another number that is the square of the first’, we have:

e) F-p (p =the function squaring takes one object as argument and delivers another object that is the square of the first) is true iff p is true at all the worlds where C, the functional capacity of squaring, is correctly enabled by the argument, or in Frege’s terminology, all the worlds where the function squaring is correctly saturated by its argument, and so correctly yields Cn, which is to yield the correct value as the square.

But of course mathematical objects, such as the function squaring, are in all possible worlds and so f(w) is just W, the set of possible worlds. This collapses the Kratzer-style definition into a universal statement over all possible worlds.

 Let f be a variable ranging over functions, and x and y be variables ranging over objects. Let S be the function of squaring and let ES be the unary property of S’s being correctly enabled by some object. Then:

 (f)(x)(((f = S) & (ESx)) →(∃y)(y = Sx))

Which gives us:

 F-p (for p=S squares) is true iff: for all functions f, objects x and y, if f = the function of squaring and if x properly enables the function of squaring, there exists a y that is the square of x

For necessarily existing objects the Kratzer-style definition contributes nothing new. It’s not false, but it collapses into the necessary universal statement. The parallel with the other sorts of function is still there, and the analysis of mathematical function as a structure of capacities still holds, but the Kratzer-style truth conditions, while true, are no longer enlightening.

4.2 A schema for formal truth-conditions for function

Truth conditions for the well-enough enabling types of function

F- p is true at w with respect to f and g iff for all u ∈ ∩f(w), there is a v∈ ∩f(w) such that

1. v ≤g(w) u

and

1. for all z ∈ ∩f(w): if z ≤g(w) Z, then z ∈ p

Simplifying somewhat, a proposition is generically a functional necessity just in case it is true at all the accessible worlds (the f(w)) which are ranked as high or higher than Z. So for the case where the f(w) worlds invoked are the worlds of some appropriate C-structure and the g is the evaluative how well enabled as applied to the successive Ci, the proposition p is functionally the case if the Ci are well-enough enabled to enable Cn.

Kratzer’s treatment of the ordering source can be left unchanged for my account of the better/worse enabling sort of function, since it is a simple betterness - ranking and that is what is required for those sorts of functions. Here it is:

 Inducing the ordering ≤A:

For all worlds w and z ∈W: w ≤A z iff {p: p ∈ A and z ∈ p} ⊆ {p: p ∈ A and w ∈ p}

Truth conditions for correctly enabling types of function

Let R stand for “right” as a sorting value as applied to worlds. “Correct” is equally a sorting value but its treatment is exactly parallel to “right” so I will not repeat. Then:

 F-p is true in w with respect to f and g iff:

1. for all u ∈ ∩f(w), u ∈ Rg(w) or u ∈ not-Rg(w)

 and

1. for all z ∈ ∩f(w): if z ∈ Rg(w) then z ∈ p

What this schema says is that F-p is true iff p is true in all the Rg(w) worlds, the “right” worlds, the worlds at which the unary relation of “rightness” is exhibited. And since we are talking about function, we are to take it as equivalent to rightness or correctness of enabling (or success of saturation). And of course it is to be understoodto be the “right/not-right” unary relation counterpart of thev ≤g(w) u “better than” binary relation.

 Inducing the RA sorting:

1. For all worlds w ∈W: w ∈ RA iff {p: p ∈ A and w ∈ p}

With regard to the sorting, notice that this amounts just to saying that the A-list of propositions lists the ‘right’-assigning (or the ‘correct’-assigning) conditions for the particular g acting on the f(w) we are dealing with, and so if p ∈ A (if p is contained in the group of worlds manifesting the right/correct conditions) then p ∈ RA which is to say that p will be contained in the set of worlds of f(w) that define the Rg(w) sorting on f(w), i.e., the “right” worlds.

We are giving a semantics for function, so the f(w) introduced in the conversational background are worlds exhibiting the appropriate functional C-structure for the type of function at hand, and the correctly enabling value is the enabling that is correct for that C-structure and context.

4.3 Function in biology is an empirical deontic modal

Function, I am arguing, at least in biology and physical science, is an empirical deontic modal word and phenomenon. What does that mean? Kratzer’s treatment clearly separates factual from normative and because the g, the norm, is essential in her treatment, there is always an evaluative of some kind present. So does the evaluative in the semantics make the function-statement itself non-empirical because evaluative? The answer is that it depends on the kind of evaluation.

Clearly, if there is any objectionably non-empirical element in function-statements, it must be contributed by the evaluative element. It could arise from an illicit sort of norm – e.g., a moral, legal or teleological norm – coming to be applied to some matter of science or mathematics. But the evaluative always takes the character of the context. If you are talking about the moral, it is morally good, if about means-ends deliberation, it is instrumentally good, if about the legal it is what is legally good (right, actually, since legal/illegal is a right/wrong, yes/no matter). And so for functions of the well-enough enabling sort, it is about how well Ci enables C1+1, and whether that is done well enough to achieve the Cn condition. But in the biological and physical sciences, that is an empirical question and condition. Doing something well enough to bring about something else is an empirical property, so long as the doings themselves are empirical.

The various function-statements will differ appropriately: biology and chemistry and physical law functions are empirical, agential functions are instrumental but may be empirical or normative, depending on the subject-matter, and mathematical and conceptual/logical functions are mathematical and conceptual/logical in the nature of the evaluative. The kind of evaluative follows the subject matter and doesn’t change it. The upshot is that items of the semantic category of being a deontic modal are related to a factual condition, a modal condition, and an evaluative condition, but may or may not be non-empirical, depending on what the value is and what is being evaluated.

4.4 How function and supposed to are related

To see how function and supposed to are related, what we need to see is the relation between the truth-conditions of the two types of sentences. Notice that supposed to pairs with the “well-enough enabling” type of function, and must with the “correctly enabling” type. I will treat them in turn.

 F-p is true iff p is true at all the well-enough enabling C-structure worlds, which are those in which Ci enables Ci+1 well enough that Cn

 S-p is true iff p is true at all the good enough f(w) worlds, that is, the worlds that are highly enough ranked in the better-than ordering established by the evaluative g

But then if the f(w) worlds are the C-structure worlds, and the g evaluative is the “how well enabling” evaluative, what results is a true supposed to sentence with the same truth-conditions as the function sentence.

Let me say that again: for the S-p sentence above, consider the case in which the f(w) are the worlds with the appropriate C-structure, and the g ranks those worlds as to how well the C-structure is enabled. And those conditions mean that the S-p sentence will be true if the corresponding F-p sentence is true.

And so:

F-p entails S-p for all true F-p sentences of the “better/worse enabling” variety of function

The reverse is false, of course, since supposed to sentences are true for p’s that don’t make true function-statements.

And in parallel fashion for the types of function where the enabling is “correct/incorrect” we have must instead of supposed to, and so the schema is:

F-p entails M-p for all true F-p sentences of the “correctly enabling” variety of function

So we can see how the formalities work, but how should we understand what is happening? Have we unwittingly re-introduced the old value-laden element back into our analysis of function? The answer is no, we haven’t done that, because the evaluative we use in the F-p that entails the S-p is empirical in biology and chemistry and physics, instrumental in agential function, and is mathematical/logical in mathematical/logical functions – enabling well-enough or enabling correctly is an empirical matter in biology, chemistry and physics, and enabling correctly is a mathematical/logical matter in mathematics/logic. The underlying property in all function is that of Ci doing Ci+1 well-enough/correctly to enable Cn.

**5.0 Afterword**

My aim has been to give a full and rigorous account of our uses of function-statements. To do that I attempted to show that functions are deontic modal properties, and are, in the biological and physical cases, empirical deontic modals. Elsewhere, e.g. for normatives such as the purposive, the law or the moral, they are, respectively, teleological, legal or moral deontic modals; and for semantic and mathematical function-statements, semantic or mathematical deontic modals. This is an interesting and I think powerful result with great strength to unify. And as a nice byproduct, I think my account shows why functions and function-statements are so useful in describing and understanding complex biological and physical systems with complicated and extended “necessary and almost sufficient” causal linkages and “other things being equal” qualifiers. They are especially useful in those “typically necessary and sufficient, and other things being equal” sorts of case because we can use them even though we know relatively little about the underlying biological or physical facts that bring them about.

I began this effort because I needed an account of function and function to deploy against a quite different problem in an entirely different project. I have developed the account of function I needed, but the investigation has proved wonderfully interesting in its own right. And as a purely personal aside, 45 years ago when I was a graduate student I tried to write a paper arguing that biological and mathematical function-statements had the same underlying logic. I failed then, but sometime about half-way into my work on the topic now, it began to seem that I had the means to make the argument and so I have tried to do that. The effort has led me into difficult and treacherous areas and my success has been partial at best, but, I hope, interesting and suggestive.

Readers’ comments on this paper are very welcome.

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NOTES

1. Perlman, like many others, makes what I think is a serious mistake about teleology and functions. The problem is his understanding of teleology, where I believe he confuses goal-direction in creatures with the sort of end-orientation that is found in Aristotle’s theory of final cause, and then conflates those with the kind of “for the sake of which” that is found in functions. The metaphysics of these three conceptions are possibly quite different, the first two certainly. Being goal-directed, i.e., being capable of purposive action in pursuit of one’s goals, is some sort of behavioral and dispositional property of organisms. Aristotle’s final cause is the metaphysical property of a thing’s having a “natural” end-state, as in, e.g., the natural end-state of matter is to be solid. The kind of teleology found in functions is perhaps yet different. One could have an Aristotelian explanation of function, a goal-direction explanation of function, or yet some other kind (e.g. a deontic modal explanation, as I am offering). Calling all this ‘teleology’ is confusing and confused. The one common factor is in all cases that an explanation of a thing’s happening is offered in terms of “what it is for”. But that is the unexplained core of all the ideas, and is itself almost certainly ambiguous. Merging them all together into a single idea of “teleology” is not useful or, I think, correct. [↑](#endnote-ref-1)
2. There are five things wrong with the evolutionary sort of theory of function in all its formulations, if what we are after is a broadly explanatory account of function and function that works both for the needs of science, and for linguistics in its interest to address all uses of function. First, it requires a theory like Cummins’ to identify what we might call “proto-functions”, which are the causal configurations that, through evolutionary selection, confirmation and continuance become functions proper. You can’t start with just anything, but only with a configuration with certain causal dispositions and relations. The evolutionary theory in its simpler formulations speaks as if nothing can be selected by evolution unless it is a thing with a function, and that it is in virtue of what its function is that it is selected. But that is circular. The process has to start with something that is not a function, and we need to be able to characterize that thing, and then say how, through evolution, it comes to have or be a function.

Second, and related to the problem of the proto-function that becomes a function through evolution, is the problem of a configuration that arises full-blown, doing just the thing at its inception that it does in future generations. Evolution has not selected for it, initially or in subsequent generations, but rather confirms its usefulness as an adaptation, so to speak. How is this configuration not a thing with a function from the beginning? Evolution doesn’t change it. Does the evolutionary “confirmation” turn what was only a proto-function into a function? Is “confirmation” really an aspect of selection? This doesn’t sound plausible.

Third, it provides no account of non-biological system function or of agential function.

Fourth and if all of these issues were to be dealt with, there is still the ‘supposed to’ problem. Some of the evolutionary theorists say that their theory does provide the ‘supposed to’ feature, that in their theory there is a relevant sense in which, e.g., the heart is ‘supposed’ to pump the blood. But that claim is unclear. It is a ‘not very normative norm’ Hardcastle (2002, 150) says. Millikan (1984, 33-34) says she understands the normative aspect of function to be based on her technical definition of normal as that appears in normal functioning, and she defines normal functioning using her concept of proper function. A concept of ‘supposed to’ so defined is not at all our ordinary normative concept. It is really just the contrast of proper function (normal function) and not-normal function, which is not the same thing as to be supposed to and if normative is so in a specialized way.

And fifth, there is the problem of polysemy. Maybe we can’t find an account of function and function that avoids all or some of the polysemy implicit in the approaches which give radically different theories of function for each of the types of function, but these theorists just aren’t concerned to try, and that is a problem.

If nothing better comes along, I expect the evolutionary account will carry the day for biology, and that we will gloss the issue of ‘supposed to.’ We will develop other accounts, perhaps quite unrelated, for our other uses of function. This lack of theoretical unity will be disturbing, but perhaps unavoidable. The concept of function is useful in biology, but it is especially useful in ordinary thinking and we are just not going to give it up. We will use the agential theory for the agential functions, and we will treat the chemical cases as agential when pressed by philosophers although we won’t believe it. As philosophers, we will not have ‘for’ except for the artisanal case, and we will not have ‘supposed to’ at all. But as ordinary citizens we will go on talking in the same old ways, we know we will. That is a very uncomfortable outcome. It brings to mind the story Kratzer (2012, p.8) tells about an old positivist philosophy professor she studied with, and how it seemed to her that what he wanted was to show that all the interesting but puzzling things were meaningless, whereas what she wanted was to show how they meant what they meant. [↑](#endnote-ref-2)
3. A puzzle posed by my friend Steve Savitt, who kindly performed the first reading of this paper. [↑](#endnote-ref-3)
4. Against the evolutionary function theorists Cummins argues that evolution and natural selection explain why this rather than that feature of an organism is realized, but that it has the function it has does not so explain. He says the evolutionary theories get the explanatory order reversed, that evolution explains why a thing with these properties exists, but that the thing’s having the properties and so the function that it currently has plays a very small part in the scientific account of why it was selected for by evolution. Being selected has at least as much to do with the environment the selection happened in as it does with the capacities of the feature of the organism in question. It is always the combination of the creaturely properties and the causal context in which the creature is struggling that explains selection, so that the feature with the function, in a different context, would not be selected for. For that reason, Cummins says, the evolutionary theory will not support the right sorts of counterfactuals. That some creature has the function-feature is not sufficient to ensure that the function-feature will be selected for; and it is not necessary that it is selected for because it has the function-feature. It usually is, and will be; but that is Cummins’ point, that functions do not figure in explanations at the fundamental level. However, these are complicated matters, and the argument has become too complicated for me to usefully pursue further here. [↑](#endnote-ref-4)
5. Heck and May (2016) make this point in their paper ‘The Function is Unsaturated’ where they investigate the peculiar point Frege makes, that which is the function and which the object is in a sense something we can choose depending on our purposes. Looking at mathematical equations certainly suggests that you can always turn the elements of the equation around and invert the object/function relationship. This point also relates to Frege’s belief that the thought, the proposition, is the starting point and that function and object are derived from how the whole is subsequently divided. If we were to extend this to states of affairs, one could articulate a Fregian theory of object/property that would have some interest. There are complications in this which I won’t explore here. [↑](#endnote-ref-5)
6. Why are we not ready to attribute a function to the force itself? We seem happy to attribute function to the gravitational field and to the masses but not to the force. Why? Consider that if we tried to say ‘the function of Force is to …’ we would have a metaphysical unhappiness. Except perhaps in speaking as a Star Wars fan, but there “The Force” is taken to be a field of power that pervades the universe, perhaps like the gravitational field. A physical function is a dispositional property of something, but force in Newtonian physics is always taken as a relational, non-substantive aspect of the substances involved; and so for instance our readiness to attribute function to the gravitational field shows that we think of it substantivally. Nothing is proved by these observations, but they tend to show a consistency among our uses of *function* and our other metaphysical views. [↑](#endnote-ref-6)
7. Portner (2009) is an extremely useful survey of the linguistic and philosophical sources and thinking on non-alethic modality. He distributes credit broadly but acknowledges Kratzer as primary. [↑](#endnote-ref-7)
8. Frank Jackson (1985) writes interestingly about the semantics of *ought*. He argues for two main points, (1) that the truth of *ought*-statements always are to be judged relative to a contextually provided set of possible outcomes or things that ought to be the case, and (2) that that set of possible outcomes, or “options” ought always to be or include what will actually be the case if the p of the O-p is or were to be the actual outcome. Kratzer does not address these finer points, but her schema can capture or express them if Jackson turns out to be correct about the matter.

 [↑](#endnote-ref-8)
9. The problem of best vs. good enough seems to have connections with the problem of whether, as some examples suggest, ought-p itself has a more/less character. If so, then the various oughts will be arranged on a better/worse scale of more/less important, and so good enough will be the relevant evaluative dimension in the truth-conditions, and not best. See Portner, Rubinstein (2016) for interesting discussion. [↑](#endnote-ref-9)
10. Notice that I am here *de facto* including some sort of calculation of relative worth based on likelihood of end-realization and on trade-offs among ends. This is in some sense a contested issue, but it is hard to make an example at all realistic without including calculations of relative likelihood. Also, I think that it is wrong to attribute goal-direction to an entity that has only one goal and so makes (can make) no trade-offs or judgements of likelihood. That entity is a mechanism, or if (an otherwise) purposive organism, pathological. And in fact we do relative likelihood calculations all the time in weighing courses of action. How that should be captured in the semantics is what is at issue. See for instance Wedgwood (2016) for a useful discussion and an entry into the issues. He advocates inclusion into the semantics by way of the inclusion of expected utility calculations. See also Cariani (2016). [↑](#endnote-ref-10)
11. Notice that Kratzer’s formulation leads naturally to expressing the *best*-consideration as ‘best morally’ or ‘best instrumentally’ and etc. This means that if Thomson (2008, pp. 1-19) is correct, and that all uses of *good* (*better*, *best*) are attributive uses and there is no such thing as intrinsic good, that Kratzer’s theory will work; and if there is an intrinsic good, and if all the “ways” of being good are to be explained in terms of it, that Kratzer’s theory also works. It can be agnostic about the issue. [↑](#endnote-ref-11)
12. This method of ordering is inadequate, certainly for the moral, probably for all except basic preference orderings. Some proposition p∈A may be morally or otherwise more important than some q∈A but Kratzer’s theory cannot deal with relative importances, it deals only with numbers of compliance instances and ranks all compliance-instances equally, which is surely false. But this is a topic for another occasion. [↑](#endnote-ref-12)
13. The point here is the same as in Note 10. [↑](#endnote-ref-13)
14. Bjornsson and Shanklin (2014) argue for the right/wrong, yes/no, binary ordering for *must* vs. the better-than ordering for *ought*. I agree with them and borrow from their approach and attempt to extend it. [↑](#endnote-ref-14)