The Indispensability of Relational, Adapted, and Derived Proper Functions

Abstract

Since the early debates on teleosemantics, there have been people objecting that teleosemantics cannot account for evolutionarily novel contents such as "democracy" (e.g., Peacocke 1992). Most recently, this objection was brought up by Garson (2019) and in a more moderate form by Garson & Papineau (2019). The underlying criticism is that the traditional selected effects theory of functions on which teleosemantics is built is unable to ascribe new functions to the products of ontogenetic processes and thus unable to ascribe functions to new traits that appear during the lifetime of an individual organism.

I will argue that this underlying thought rests on rather common misunderstandings of Millikan's theory of proper functions, especially her notions of *relational, adapted, and derived proper functions* (Millikan 1984: Ch. 2). The notions of relational, adapted, and derived proper functions not only help us solve the problem of novel contents and can ascribe functions to the products of ontogenetic selection mechanisms but are indispensable parts of every selected effects theory.

1   The Challenge for Millikan's Theory of Proper Functions

Millikan's theory of proper functions – the "traditional theory" – states that a thing's having a (direct) proper function does not consist in having a certain disposition, but in the fact that *the ancestors* in the reproductive lineage of the thing were *selected for* because they showed certain effects. Millikan's teleosemantics is built on this theory of proper functions and analyzes the contents of (mental) representations in terms of their proper functions. Very roughly, a descriptive mental representation represents the state of affairs on which the fulfilment of its proper function depends. Mental content is thus dependent on some evolutionary process.

A common objection against teleosemantics is the problem of evolutionarily novel contents that teleosemantics supposedly cannot account for contents that had no relevance in our evolutionary history (cf. Dretske 1986: 28; Sterelny 1990: 129; Peacocke 1992; Beckermann 2008: 373; Garson 2019: 101; Hundertmark 2021; Schulte & Neander 2022):

> At best, teleosemantics might help us understand what it is for frogs to represent flies or for vervet monkeys to represent eagles. It doesn't help us understand, however, how animals can represent evolutionarily novel features of their environments, such as microwave ovens or celebrities […]. After all, teleosemantics says that in order for a representation to be about something, there must be

some mechanism in place that has the evolved function of making the organism respond, in the right sort of way, to that thing. However, since no mechanism has the evolved function of making organisms respond in any particular way to microwave ovens or celebrities, teleosemantics is quite limited in making sense of our representational capacities. (Garson 2019: 191)

A related objection against Millikan's theory of proper functions has been raised by Krohs (2011) who argues that the EvoDevo tradition has shown that environmental factors can lead to new traits without there having been a selection process for these specific traits. As Millikan's theory can, according to Krohs, only ascribe functions to traits that have been selected for, it cannot ascribe functions to such new traits.

Further examples of new traits that Millikan's theory is unable to capture are, according to Garson (2019: Ch. 4-5), products of neural selection and behaviors selected through operant conditioning.

To nevertheless be able to ascribe functions to the products of these processes, Garson (2019) (and Garson & Papineau 2019) have recently proposed a *generalized* selected effects (GSE) theory.[1] According to GSE, not only processes of differential reproduction, but also processes of differential retention or persistence (within a population) can lead to new functions. Garson (& Papineau) claim that GSE accommodates other kinds of selection besides natural selection in which nothing is reproduced and thus can ascribe new direct proper functions – or "persistence functions" – to things that were selected for but are not reproductions.

The underlying point of these objections is the impression that Millikan's traditional selected effects theory cannot ascribe new functions to new traits that arise as the products of ontogenetic processes during the life span of an individual organism and thus have no direct (evolutionary) selection history themselves.

Interestingly, Garson (2019) (and Garson & Papineau 2019 even more) does not really think that Millikan's theory is unable to ascribe new function in such cases. Garson concedes that the job might be done by Millikan's notion of *adapted* and *derived* proper functions:

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[1] Garson's (2019) and Garson & Papineau's (2019) main argument for their generalized selected effects (GSE) theory is not that their theory offers a solution to the problem of novel contents/traits. The main argument is that the reasons for accepting the traditional theory also hold for the generalized theory, and since the generalized theory comes without an arbitrary restriction – the reproduction restriction –, selected effects theorists should accept the generalized theory (cf. Garson 2019: Ch. 6.1). However, as it should become clear throughout this paper, they use the problem of novel contents as a secondary argument for their GSE theory (although more strongly in Garson 2019: Cf. 12 than in Garson & Papineau 2019). As the aim of this paper is not to argue against GSE but only to demonstrate the indispensability and explanatory power of relational, adapted, and derived proper functions that has been underappreciated in Garson (and Papineau's) discussion of GSE, I will refrain from discussing the main argument for GSE. For a detailed reconstruction of their main argument, see Fagerberg (2022).

> if all we care about is "getting the job done," then the traditional selected effects theory, along with the distinction between direct and derived proper functions, will do that job. If all we want is a theory that lets us give functions […] to the products of synapse selection (say), then that mix of theories will work. (Garson 2019: 100-1)

However, Garson thinks that introducing derived proper functions is an *ad hoc* solution:

> Millikan's approach *lacks a certain elegance* one might wish for in a theory of function. It first banishes nonreproducing entities from the realm of direct proper functions. Then it helps itself to another distinction, between direct and derived functions, to confer functions of a lesser rank upon them. But […] why rely on these *cumbersome tactics to bring them back in*? I have no problem with direct and derived proper functions, per se [...], but *we shouldn't have to rely on this distinction to do the work that our core theory should do all alone*. (Garson 2019: 101, emphasis added.)

In their joint paper, after considering that derived proper functions may do the desired work, Garson and Papineau more moderately write:

> we think it is problematic to explain the functionality of these ontogenetically acquired neural structures in terms of derived proper functions. (Garson & Papineau 2019: 15.)

While some authors (e.g., Beckermann 2008: 373; Krohs 2011) claim that Millikan's theory cannot ascribe functions (and thus content) to novel traits without discussing her notions of relational, adapted, and derived proper functions, Garson and Papineau agree that these notions are well-defined and can do some explanatory job. The disagreement between Garson (& Papineau) and Millikan thus mainly concerns the status of adapted and derived proper functions and how exactly they work.

Also related to Millikan's distinction between direct, adapted, and derived proper functions, Capraru (2024: 14-5) claims that Millikan's account is disunified because it does not explain what renders them the same kind of function.

I will argue that this whole family of objections stems from underappreciating certain elements of Millikan's theory, specifically her notions of relational, adapted, and derived proper functions. Most importantly, I will argue that the way that adapted and derived proper functions are defined in Millikan's theory is in no way artificial or *ad hoc* and does not do some "work that our core theory should do all alone." Adapted and derived proper functions are merely redescriptions of *relational direct* proper functions – functions to produce certain relations between one thing and another –, and such *relational* functions are perfectly normal direct proper functions. If there are relational proper functions, which of course there are, the rest simply follows. Further, adapted and derived proper functions have way more explanatory power than Garson seems to think. They can very well account for evolutionary novel contents

and ascribe functions to the products of ontogenetic selection mechanisms. And finally, I will show, contra Garson & Papineau, that ontogenetic selection mechanisms hijacked by drug ingestion still produce adapted devices with derived proper functions.

2 Relational, Adapted, and Derived Proper Functions

Objects can only have *direct* proper functions (as defined by Millikan 1984: Ch. 1) if they are a member of a (first- or higher-order) reproductively established family[2] and if their ancestors within this family have been selected for producing a certain effect.

Within the realm of *direct* proper functions – the realm that Garson regards as the core theory – some things have *relational* direct proper functions. This means that their direct proper function is not to produce a certain absolute effect. Rather, they are supposed to produce something that bears a certain *relation* to something else already given. To use Millikan's classic example, the chameleon's skin pigment rearrangers do not have the direct proper function of producing a definite skin color; they have instead the relational direct proper function of producing a *skin color that matches* (=the relation) *what the chameleon is sitting on* (=the given relatum) (cf. Millikan 1984: 39-40).[3]

> Some direct proper functions are *relational.* An item *A* that has a relational proper function is supposed to produce something that bears a certain relation to something else *B, B* being "so situated" in relation to *A.* (Millikan 1984: 49)

In Millikan's terminology, the thing to which the chameleon skin's pigment rearrangers are adapted in a certain situation – the thing on which the chameleon is actually sitting – is called the "adaptor." Derivative of the relational direct proper function to produce a background-matching color and a specific context with a specific *adaptor*, the chameleon skin's pigment rearrangers have as an *adapted proper function* to produce a green skin color.[4]

> If there is something B that is "so situated" in relation to *A, A* becomes for the moment *adapted* and acquires an *adapted proper function.* B is now the current *adaptor* for *A* and for this adapted function of *A.* (Millikan 1984: 49)

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[2] See for the definition of reproductively established families Millikan (1984: 23-5).

[3] I just assume for the sake of demonstrating how the notions of relational, adapted, and derived proper functions work that producing a background-matching color is a function of the chameleon skin's pigment rearrangers. The proper function might in fact not (only) be camouflage, but, for example, (also) social signaling, cf. Stuart-Fox & Moussalli (2008), Ligon & McGraw (2013).

[4] The notion of adapted proper functions is not related to the notion of adaptations.

This adapted proper function is derived from the relational proper function and a certain adaptor. In this way, things can have adapted proper functions that are entirely new – absolute effects that have never been shown by any ancestors in the selection history.

The thing that is produced by performing such an adapted proper function is an *adapted device*. As it is not a member of any reproductively established family, an adapted device does not have a direct proper function.[5] It can, however, have a proper function that is derived from the proper function of its producers, a *derived proper function*:

> Functions of *A* that lie beyond the production of any adapted device *D* that *A* produces are *derived proper functions of* D, derived from *A*'s proper function plus, perhaps, *A*'s current adaptor. (Millikan 1984: 49)

"Lie beyond" is to be understood very specifically. The derived proper functions that an adapted device can have are only those proper functions of its producer that stand in a *serial* relationship (i.e., one function is performed by first performing the other) to its producer's proper function to produce the adapted device. Furthermore, the proper functions that an adapted device can have as derived proper functions must be more distal than this function. Other proper functions of the producer of the adapted device that stand in *alternative* or *simultaneous* relationships to the proper function of producing the adapted device cannot be derived proper functions of the adapted device. Two proper functions stand in an alternative relationship if they are performed independently from each other on possibly different occasions, e.g. the feathers of the waterfowl's functions to keep them warm, trap air that keeps them afloat and dry, etc. And they are simultaneous if they must be performed all at once, e.g. the blood's functions to carry oxygen, carry nutrients, carry hormones, etc. (cf. Millikan 1984: 35).

This leaves us at this definition of derived proper functions:

Derived proper functions

(DPF) An item *m** has effect F_2 as *derived proper function* iff:

    (1) *m* has F_1 and F_2 as proper functions,

    (2) F_2 *is* performed by first performing F_1 (i.e. F_1 and F_2 stand in a serial relationship and F_2 is a more distal proper function of *m* than F_1),

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[5] Described relationally, it may have a direct relational proper function due to being a member of a higher-order reproductively established family, cf. Millikan (1984: 42). For example, concrete waggle dances are adapted devices, adapted to the dance-producing mechanism and the source of nectar and have derived adapted proper function, e.g., to fly north-east for 1 mile. Described relationally, waggle dances are a member of the higher-order reproductively established family of syntactically correct waggle dances and have as such the direct relational proper function to make other bees fly in the direction that corresponds to the waggle dance's structure.

(3) m^* has been produced by m in accordance with an explanation that approximates (in some undefined degree) to a Normal explanation of how m performs F_1.[6]

To see how these notions can be applied, consider Millikan's (1984: Ch. 2) example of bee's waggle dances. A bee's dance producing mechanism has the *relational direct proper function* of ($1_{r,d}$) producing a waggle dance that bears a relation to a previously found source of nectar and to ($2_{r,d}$) make the other bees fly towards that source and the *non-relational direct proper function* of ($3_{\neg r,d}$) bringing in nectar. It then also has as an *adapted proper function* to (1_a) produce a certain waggle dance and to (2_a) make the other bees fly southeast. The performed waggle dance is an adapted device adapted to the previously found source of nectar. The waggle dance now has as a derived proper function the proper functions of the dance producer that lie beyond the production of the dance itself, that is, the *adapted derived proper function* of ($2_{a,der}$) making other bees fly southeast and the (non-adapted) *derived proper function* of ($3_{\neg a,der}$) bringing in nectar (cf. Table 1).

Table 1: The different proper functions involved in waggle dances.
(d: direct, r: relational, a: adapted, der: derived)

dance producing mechanism		*performed waggle dance (adapted device)*
relational direct proper function: ($1_{r,d}$) produce a waggle dance that bears a certain relation to a previously found source of nectar	*adapted proper function:* (1_a) produce a certain waggle dance	
relational direct proper function: ($2_{r,d}$) make the other bees fly towards that source	*adapted proper function:* (2_a) make the other bees fly southeast	*adapted derived proper function:* ($2_{a,der}$) make other bees fly southeast
direct proper function: ($3_{\neg r,d}$) bring in nectar		*derived proper function:* ($3_{\neg a,der}$) bring in nectar

Since the dance producing mechanism has two relational proper functions that stand in a serial relationship ($1_{r,d}$ and $2_{r,d}$), the adapted device (i.e., the waggle dance) acquires the more distal one as an *adapted* derived proper function. In this way, it is possible that an evolutionarily novel trait (i.e., the waggle dance as adapted device) is produced by the performance of an evolutionarily novel adapted proper function (1_a) and itself acquires a further evolutionarily novel adapted derived proper function ($2_{a,der}$).[7]

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[6] Cf. § 6 for a discussion of the third condition.

[7] Note that Millikan's theory nevertheless cannot ascribe functions to every novel trait. The commonly noted implication of selected effect theories remains that the first occurrences of a trait in evolutionary history, given that they are not an adapted device, do not have any selected effects function. This holds for both Millikan's theory and for GSE, with the only

3 Adapted Proper Functions, Novel Contents, and Teleosemantics

Depending on what the relational function is, adapted proper functions are more or less restricted. In contrast to the relational functions involved in the bee's waggle dance case, the relational functions of the mechanisms that play a role in concept formation are very flexible, so that pretty much anything can be the adaptor, hence pretty much anything the referent of a newly formed concept. It is plausible that there are mechanisms involved in concept formation that could have the relational proper function to produce concepts *of whatever it was that was just experienced*, and so have the derived proper function to collect and store information about exactly this (kind of) thing.[8] For example, given a certain context in which someone first hears about democracy, the concept formation mechanism would have the adapted proper function of producing a concept of democracy that collects and stores information about democracies, and the resulting concept then has the adapted derived proper function to collect and store information about democracies.[9] This is an evolutionarily novel function, but is nevertheless completely in accordance with evolutionary design. The same goes for other novel contents such as communism, Mastodon, microwave-ovens, etc. As soon as we acknowledge the flexibility of relational and derived proper functions, the problem of novel contents just disappears.[10]

This flexibility of relational and adapted proper functions is simply denied (or at least overlooked) by Garson which is why there appears to be a problem of novel contents for Garson:

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difference being that in GSE a process of differential retention can also lead to new functions, whereas reproduction is required in Millikan's theory. Some kind of prior selective process is always needed. Note also that the lack of functions in the first occurrences of a device implies that the products of these devices do not have a derived function. Where there is no relational proper function, there is also no adapted proper function; and where the producing device has no proper function, the products are not adapted devices and do not have a derived proper function either. Therefore, the way how novel traits can acquire proper functions that I discuss in this paper only works if these traits are produced by an already evolved mechanism. I thank an anonymous reviewer for suggesting discussing this.

[8] Cf. Millikan (2017: Ch. 5) for an extensive discussion of such mechanisms and Ryder (2006) for how this might be realized in our brains.

[9] Garson & Papineau (2019: 14-5) acknowledge that the products of classical conditioning have (representational) derived proper functions, derived from the function of the classical conditioning mechanism of "enabling organisms to form neural associations that will represent whatever regularities happen to be displayed in their current environments" (Garson & Papineau 2019: 15). This is another example of a relational function that allows for almost anything to be the adaptor and thus be what is represented. It is thus even more surprising that Garson seems to think that adapted and derived proper functions are "limited in just the way that compositionality is" (Garson 2019: 197), see below.

[10] I do not have the space to discuss how whole mental representations get their content, but these remarks should be sufficient to show that there is no problem of novel contents in teleosemantics.

> [The direct/derived proper function distinction] can help us understand how we can represent new properties in our surroundings, but it's still quite limited. *In fact, it's limited in just the way that compositionality is, since this particular solution just exploits the fact that the waggledance is compositional.* Millikan (2004) takes pains to point out that even the simplest of signs are "architecturally complex"; they have different components, and by slightly jiggling the different components, you can "say" slightly new things. In the waggle dance, the components are the time of the dance, the place of the dance, the angle of the dance, and the speed of the dance. By changing up any of these, the bee says new things, but that strategy won't get us very far – and certainly not as far as flatbed auto-feed scanners or communism. (Garson 2019: 197, emphasis added.)

In this passage, Garson takes a really simple representational system that is only meant to represent the location of nectar – representing nectar is an invariant part of the sign family while the only variant parts are the time, the location, the distance, and the direction – and then concludes that it cannot represent communism. Of course, such a system is quite limited in just the way compositionality is, but this does not show in any way that the whole notion of derived proper functions is similarly limited.

Independently of the problem of novel contents, I think it is important to keep the central role in mind that the notions of relational, adapted, and derived proper functions play in Millikan's version of teleosemantics. Two tenets of Millikan's (2007) teleosemantics are that (1) representations are always embedded between coevolved producer and consumer mechanisms and that (2) representations always come in systems in the sense that changing a component of the representation would result in a systematic change in what state of affairs is represented. If Millikan is right about this, then the notions of relational, adapted, and derived proper functions apply to and are needed to analyze *any* representational system. Relational proper functions are needed to account for the systematical variations in function and content. And the notions of adapted and derived proper functions are needed to ascribe functions and content to the representations, as they are adapted devices and not themselves evolved.

4   Is Millikan's Theory Disunified?

In a similar vein to Garson's objection that the notion of derived proper functions is an additional distinction added to the core theory, Capraru (2024: § 3) has recently objected that "derived proper functions are an independent clause in Millikan's theory" (2024: 15) as adapted and derived proper functions are grounded differently from direct proper functions. Whereas direct proper functions are, Capraru claims, "grounded in histories of natural selection" (2024: 14), derived proper functions "result from the proximal activity of a mechanism with another proper function of its own" (2024:14). Capraru concludes that Millikan's account is disunified as it does not give an account of proper functions that applies to all functional items in the same

way:[11]

> hence there is strictly speaking no such thing as 'proper function' as such, but only direct function and derived function, with the latter being defined ultimately in terms of the former. (Capraru 2024: 15)

As a possible way to save the unity of Millikan's account, Capraru discusses the possibility that in the chameleon case it is not the concrete color that is reproduced and therefore has the function but rather the "broader matching configuration between skin and background" (2024: 15). In other words, relational descriptions might save the unity by linking adapted and derived proper functions and adapted devices back to (relational) direct proper functions. However, Capraru seems to use things with non-relational proper functions such as pens as counterexamples for this strategy, and therefore rejects the move.[12]

In some way, Capraru is right, that Millikan has no definition of proper functions *simpliciter*. But neither does this render Millikan's account disunified in any relevant sense, nor is Millikan unable to explain "what renders direct and derived proper functions the same kind of function" (2024: 14).

There are two types of unity one might wish for in an account of etiological functions. First, one might find it desirable to ascribe to all traits the same kind of function. This motif is clearly visible in Capraru's complaint that derived proper functions are an independent clause, and in the rejection of the idea that relational functions might save the unity as not all functions are relational functions. However, it is unclear to me why such a unity would be desirable. Since ascribing *direct* proper functions to a trait is equivalent to saying that the trait results from a specific kind of selection process, I think it would be rather undesirable to have an account of functions that ascribes the same kind of functions also to adapted devices, i.e., things that were not themselves selected for in the past. And furthermore, there is no reason to think that either all (direct) proper functions have to be non-relational functions, or all (direct) proper functions have to be relational functions. Simple tools such as hammers and pens, and biological traits such as hearts and wings are supposed to produce always the same concrete effect, hence they have non-relational functions. Other tools such as cameras, blood pressure gauges, and many

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[11] I thank an anonymous review for suggesting discussing this point. See also Preston (1998) for this argument and Millikan (1999) for an extensive response.

[12] Capraru writes: "This […] move, however, fails as soon as we consider something as simple as a pen. A pen is disanalogous from a chameleon colour, in that a chameleon colour is produced directly in the environment that it matches, whereas a pen is produced at one time, by one factory […], only to be used at other times, often decades later, by unknown persons […]. Hence in the pen's case there is no particular device–environment match that is reproduced at all: when the pen is produced, it matches nothing in particular." (2024: 15)

biological traits are supposed to produce something that stands in a certain relation to some other thing, hence they have relational functions. This kind of "disunity" is not in any way undesirable.

Secondly, one might want a unity in the sense that there is an explanation of "what renders direct and derived proper functions the same kind of function." (Capraru 2024: 14). Capraru claims that Millikan's account does not explain this. I agree that such a unity is indeed desirable but disagree that Millikan's theory does not account for this kind of unity. The short version is that all proper functions essentially involve a selection history (cf. Millikan 1999: 202). The long version, which I will discuss in the next section, is that adapted and derived proper functions are nothing more than redescriptions of an underlying direct proper function and a certain context. Consequently, Capraru is also wrong in claiming that adapted and derived proper functions are grounded differently from direct ones. Of course, they are not the result of their own selection history but are instead grounded in the very same selection history that grounds the underlying direct proper function.

5 The Status of Relational, Adapted, and Derived Proper Functions

The notions of adapted and derived proper functions are neither a second theory additional to the core selected effects theory (remember: "that mix of theories" Garson 2019: 101), nor "an independent clause in Millikan's theory" (Capraru 2024: 15). Instead, as I will lay out in this section, they are merely a "useful nomenclature […] merely a way of talking more easily about phenomena that had already been captured by [the notion of direct proper functions], given that traits and mechanisms can have relational proper functions" (Millikan 1999: 200-1).

The existence of *relational* direct proper functions is not some strange way of constructing a theory of functions, but, given that there are proper functions at all, rather just a natural fact. There are things that have as a direct proper function to produce a certain *relation* regardless of whether we find that theoretically elegant or not.

Adapted proper functions, then, are just redescriptions of the relational direct proper functions in which the adaptor, the thing to which the adapted item is supposed to bear a certain relation, is explicitly mentioned. Referring to an adapted proper function F_a amounts to nothing more than saying that a certain thing has a relational direct proper function and is in a certain context so that the *concrete effect* that it is supposed to produce *in this context* – the adapted proper function – is F_a (cf. also Millikan 2002: 128).

That the produced adapted device has *derived* proper functions may be surprising at a first glance, but the derived proper function is also what we would expect an adapted device to perform. Of course, the green-brown pattern on the chameleon skin is supposed to "make the

chameleon invisible to predators, hence, to prevent it from being eaten" (Millikan 1984, 42). The derived proper functions of adapted devices are just continuing to perform the proper functions of their producers amongst which the production of the adapted device was the first step. They too are simply redescriptions of direct proper functions.

This is the way the various functions of things such as waggle dances unfold. Selected effects theorists need to accept that relational proper functions exist whether labeled in some special way or not, that their respective selection history cannot be told in terms of non-relational direct proper functions, and that adapted proper functions are just redescriptions of relational direct proper functions that explicitly mention their adaptor. Adapted devices have as derived proper functions merely those functions of the devices that produces them that lie beyond producing the adapted device, their derived proper functions are thus also nothing more than redescriptions of the underlying (direct) proper functions of their producers.

The notions of relational, adapted, and derived proper functions are not *ad hoc* additions to the "core theory", introduced to remedy the (supposedly arbitrary) restriction that only reproduced traits can have direct proper functions. Instead, they are introduced to link in a theoretically controlled way different kinds of not directly selected traits to the selection history[13] that (together with the specific context) grounds their functions.[14] In this way, these notions account for how evolutionarily novel traits can be, despite their novelty, in accordance with evolutionary design.[15] They are not added ideas (or a second additional theory) used to solve different problems, but rather an implication of the original theory. If there are relational functions, which of course there are, the rest simply follows, as "every reference to an adapted or derived proper function is really an implicit reference to one or more deeper relational functions" (Millikan 2002: 128) only described in a less general way.

Millikan's theory, especially when also considering her notions of relational, adapted, and derived proper functions, appears comparatively technical and definitively less accessible than Garson's GSE. This might (partly) explain why the full explanatory power of Millikan's theory is easily missed, and why GSE might seem like a much simpler alternative that is able to do the same job.[16] But if GSE's persistence functions exist, there will also be relational persistence functions and, when including the adaptor, adapted persistence functions, as well as derived persistence functions. The postulation of relational, adapted, and derived proper functions does

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[13] This selection can also be based on differential persistence within a population. The explanatory job done by these notions has nothing to do with the reproduction restriction and is not rendered unnecessary by dropping the reproduction restriction.

[14] I thank Matthias Vogel for suggesting this point.

[15] Adapted devices, like all functional traits, do not have to be fully in accordance with evolutionary design, see section 6 below.

[16] I thank an anonymous reviewer for suggesting this.

not make Millikan's theory less elegant or even more complicated but is instead an indispensable part of every selected effects theory of functions.

6 Hijacking the Operant Conditioning System and Adapted Devices

The problem of novel contents is only one example of an underlying problem Garson and Papineau (2019) see, namely that the traditional theory has some difficulties ascribing proper functions to the products of *ontogenetic selection processes* such as neural selection or the adaptive immune system. They then argue that their generalized theory can ascribe functions here independently of functions gained by phylogenetic selection. While discussing the anticipated objection that the traditional theory might be able to ascribe *derived* proper functions to the products of such processes, Garson & Papineau (2019: 16) admit that this is not only possible, but also consistent with current empirical knowledge:

> As it happens, all familiar examples of ontogenetic selection mechanisms, such as operant conditioning and the adaptive immune system […] are also mechanisms that have been designed by phylogenetic selection to produce derived functional traits.[17]

Since the products of all familiar ontogenetic selection mechanisms have derived proper functions, the anticipated objection goes, the generalized theory would thus ascribe the same functions as the traditional theory (although not (only) as functions derived from evolutionary history but (also) as persistence functions). So, there is no need to generalize the selected effects theory to ascribe functions to the products of ontogenetic selection mechanisms. However, Garson and Papineau argue that there are nevertheless cases where the generalized theory can ascribe functions while the traditional theory cannot.[18] Their example is the "hijacking" of operant conditioning mechanisms by the ingestion of dopaminergic substances.

They begin by describing the Normal functioning operant conditioning mechanism:

> It is widely accepted that phasic dopamine functions as a reward-prediction error signal in operant conditioning mechanisms […]. When behaviour leads to biologically rewarding outcomes, then the reward triggers the release of dopamine and leads to the reinforcement of relevant synapses. (Garson & Papineau 2019: 16)

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[17] The same is probably also true regarding the phenotypically plastic traits Krohs (2011) has in mind. The mechanisms responsible for the phenotypic plasticity have very probably undergone phylogenetic selection so that the different traits that are formed under different environmental conditions have derived proper functions.

[18] This is not Garson's main argument for GSE, but still a supplementary argument, cf. fn. 1. So, there might be other good reasons to generalize the selected effects theory.

However, things proceed differently when dopaminergic substances are ingested. Intake of such substances like amphetamines, alcohol, and nicotine causes "high levels of dopamine release *independently of leading to reward*, and so 'short-circuits' the normal reinforcement mechanism to encourage behaviours that lead to ingestion of such dopaminergic substances" (Garson & Papineau 2019: 16, emphasis added). Normally, the operant conditioning system reinforces neural structures that "*in the individual's experience* have led to biologically rewarding outcomes" (16), while the rogue system reinforces neural structures that led to dopamine release, *independently of the subjective experience of the individual*.

By viewing this short-circuited system as a function bestowing selection mechanism, the generalized theory can ascribe to the reinforced neural structure and the resulting behavior the (persistence) functions of leading subjects to seek whichever dopaminergic substance reinforced the neural structure (cf. Garson & Papineau 2019: 16). In contrast, they claim, "these functions are not derived functions resulting from the operation of the normal operant conditioning system" (Garson & Papineau 2019: 16).

What goes wrong when dopaminergic substances are ingested? Regarding the most proximate Normal explanation,[19] i.e., the least detailed explanation of how synapses are reinforced by dopamine release, everything works Normally. Less proximate Normal explanations also mention how the supporting environmental conditions, in this case the *dopamine release*, have been typically produced in historic success cases (cf. Millikan 1984: 33). As Garson & Papineau argue, the dopamine was not released in a Normal way, i.e., in the way it was typically released in historical success cases. Dopamine release is Normally caused by a subjective experience of reward, whereas such experiences are irrelevant for the dopamine release in cases of drug-ingestion. So, what goes wrong is that the neurons are not reinforced in a (completely) Normal way, but *only in accordance with a proximate Normal explanation*.

So, are Garson and Papineau then correct in assessing that the reinforced neurons do not have derived proper functions?[20] One important thing to notice in Millikan's theory is that

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[19] Normal explanations (capital letter N) of the performance of a proper function are explanations how a certain function has been typically performed in success cases in selection history. There are Normal explanations of the performance of a function on various levels of proximity. The *most proximate* Normal explanation "is the *least detailed* explanation possible that starts by noting some features of the structure of members of [the reproductively established family] *R,* adds some conditions in which *R* has historically been when it actually performed F […] adds natural laws, and deduces, i.e., shows in detail without gaps, how this setup leads to the performance of *F*" (Millikan 1984: 33). *Less proximate* Normal explanations, moreover, "will make reference as well to the historically most usual origins of conditions cited in the most proximate Normal explanation for R's performance of *F*" (Millikan 1984: 33).

[20] I do not want to discuss whether such a hijacked (or even a Normally functioning) system can be viewed as a selection mechanism in its own right, independently from any phylogenetically based functions, and therefore ground persistence

Millikan never presupposes that adapted devices that have derived proper functions must be produced in a Normal way (or even produced in such a way that they are able to perform all their functions under Normal conditions). Millikan indeed explicitly includes adapted devices that are not Normally produced, but only produced in way approximating a Normal explanation:

> Adapted devices, like members of higher-order reproductively established families, are sometimes malformed or abNormal. For we will consider anything to be an adapted device bearing the derived proper functions that its producer plus adaptor have conferred upon it so long as it has been produced in accordance with an explanation that approximates (in some undefined degree) to a Normal explanation of how that producer makes adapted devices. (Millikan 1984: 42)

Millikan has very good theoretical reasons for this. One of the main points of her etiological theory of proper functions is that it can say that malformed hearts are hearts, that malformed eyes are still eyes, and that false beliefs are still beliefs, since all these categories are functional categories. To be able to say this, she must define reproductively established families in such a way that also malformed hearts and malformed eyes are members of their respective reproductively established families and thus have the respective functions. To extend this to adapted devices is only sensible. Beliefs, in Millikan's theory, are adapted devices produced by belief-forming mechanisms that have relational proper functions. For false beliefs to be possible, there must be adapted devices, e.g., beliefs, that have not been produced completely in accordance with a Normal explanation, but only in accordance with an explanation that approximates (in some undefined degree) to a Normal explanation of how belief-forming mechanisms produce true beliefs (cf. condition (3) of (DPF) above). If all beliefs were produced completely in accordance with a Normal explanation, all beliefs would be true.

So, just because the operant conditioning mechanism does not work Normally, this does not mean that the resulting products, i.e., reinforced synapses and behaviors, do not have derived proper functions. If, as Garson and Papineau (2019: 16) admit, "all familiar examples of ontogenetic selection mechanisms, such as operant conditioning and the adaptive immune system […] are also mechanisms that have been designed by phylogenetic selection to produce derived functional traits," then they also produce derived functional traits when they are not working completely in accordance with a Normal explanation. Since synapses in drug-ingestion cases are reinforced in accordance with an explanation that approximates (in some undefined degree) to a Normal explanation of how dopamine release Normally reinforces synapses, they

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functions. This would depend on whether there is a population of things, and whether in this population, some things produce a certain effect more than others, and this then explains their further persistence. As I see it, the hardest part here would be to show that this selection mechanism really acts within a delineated population of things, cf. Conley (2020), Schulte (2021), Roloff (2023), and Garson (2024).

are adapted devices with derived proper functions, adapted to the evolutionarily acquired function of the operant conditioning system and the drug-consuming behavior that led to their reinforcement.[21] Garson and Papineau thus fail to show that there are products of neural selection processes (or ontogenetic selection mechanisms more generally) where Millikan's theory cannot ascribe derived proper functions while their generalized theory can.

Before concluding, I want to add one clarification. I do not think that anything I say in the paper provides a reason to reject GSE's persistence functions as I do not think that the case for GSE's persistence functions depends on showing that Millikan's notions of relational, adapted, and derived proper functions are limited in some way. Whether something has GSE's persistence functions is, as Garson & Papineau (2019: 15) also note, independent of whether it has reproduction-based (direct, adapted, or derived) proper functions (see also fn. 20).

7   Conclusion: Explanatory Power and Indispensability

There are a few reasons why selected effect theorists should really pay close attention to Millikan's notions of relational, adapted, and derived proper functions.

For an object to have a derived proper function, it (or its ancestors) does not have to go through multiple rounds of selection itself. It just needs to be produced by another thing in accordance with an explanation that approximates (in some undefined degree) to a Normal explanation of how its producer performs its function. Of course, the direct proper functions from which the functions of adapted devices are derived require multiple rounds of selection. But since neural selection mechanisms, operant conditioning, the adaptive immune system, etc. all have gone through a long history of natural selection, there is no further selection needed for the adapted devices produced by them to have derived proper functions. (Direct) Persistence functions, in contrast, can only be ascribed to an object if the object itself went through multiple rounds of selection.[22]

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[21] That the explanation only approximates a Normal explanation does not imply that the synapse reinforcement (or indeed anything) is malfunctioning here. A malfunction (in Millikan's terminology) would imply that the mechanism itself is broken. An unsupportive environment can lead to a failure to perform the function but is not a malfunction. In this case discussed here, there is nothing wrong or abNormal with the synapse reinforcement itself. What makes this explanation only approximate a Normal explanation is that the *supporting environmental conditions* are somewhat abNormal. Normally, the dopamine release that reinforces the synapses is caused by a subjective experience of reward and not by drug ingestion. But abNormal supporting environmental conditions (e.g., no coffee in the coffee machine) and a malfunctioning device (e.g., a broken coffee machine) are two different things. That the explanation is not (fully) in accordance with a Normal explanation does also not imply that the function is not performed, see, for example, cases of deviant causal chains of actions (cf. Roloff 2022). I thank an anonymous reviewer for raising this issue.

[22] Adapted devices do not need to be selected for themselves, so there is also *no need to delineate a population* in which their

Millikan's notions of relational, adapted, and derived proper functions have a *wide-ranging explanatorily power*. They can ascribe functions to products of phylogenetically evolved ontogenetic selection mechanisms, ascribe evolutionarily novel contents to representations, and further account for conflicts in functions (cf. Millikan 1984: Ch. 2).

And most importantly, there is no way to have a selected effect theory of functions without relational, adapted, and derived functions. Some objects, for example the chameleon skin's pigment rearrangers, dance producing mechanisms in bees, and neural selection mechanisms such as operant conditioning, just have relational direct proper functions. By redescribing them, we can also ascribe to them adapted proper functions and to their products we can ascribe adapted and derived proper functions many of which are "quite new under the sun" (Millikan 1984: 43).[23]

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selection has taken place. For something to have a persistence function, it must be a member of a population in which it has been selected for. Whether Garson and Papineau's generalized selected effects theory is able to delineate populations, especially on the level on which they claim the selection process is taking place is an open question (cf. fn. 20).

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