Information Supply and Demand:
Resolving Sterelny's Paradox of Cultural Accumulation[1]
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Abstract: Gene-Culture Coevolution (GCC) theory is an intriguing new entry in the quest to understand human culture. Nonetheless, it has received relatively little philosophical attention. One notable exception is Kim Sterelny's (2006) critique which raises three primary objections against the GCC account. Most importantly, he argues that GCC theory, as it stands, is unable to resolve "the paradox of cultural accumulation" (151); that while social learning should generally be prohibitively expensive for the pupils, it nonetheless occurs as the principle means of disseminating novel information through a culture. Sterelny holds that this is best explained by supplementing the GCC models with strong cultural group selection pressures. I argue that this is not needed. To show this I elaborate upon Joseph Henrich and Francisco Gil-White's (2001) information goods theory, developing it in terms of the market pressures that one would expect to find in an information economy. I indicate how such pressures contribute to an individual-level explanation of cultural accumulation that answers Sterelny's concerns.

As humans our survival is heavily dependent on what we know, including what we have learned from others. This should be a rather obvious point. It is equally obvious that our knowledge, on the whole, has expanded and improved over time. What is not so obvious is how this has occurred. Does cultural information evolve in a process closely parallel to genetic evolution? Does it evolve in another way? Or, must we look to some other kind of process to explain it?

Despite their evident interest, these questions have not received the philosophical attention that might be expected. One notable recent exception is Kim Sterelny's article, *The*

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Evolution and Evolvability of Culture (2006). In it he considers a number of different evolutionary theories of cultural adaptation.[2] While he finds none of these fully convincing, he favors the Gene-Culture Coevolution (GCC) approach pioneered by Richard Boyd, Peter Richerson, and their coworkers.[3] Despite this Sterelny raises some powerful objections against GCC work. He argues that as they stand the models that GCC theory rests upon are unable to explain a key aspect of human culture, its accumulative nature. Sterelny holds that the account must be supplemented with strong cultural group selection pressures if it is to be able to explain the observed adaptive benefits of human cultural knowledge.

In this article I respond to Sterelny's main objections. I show that they do not undermine the GCC account and do not provide support for Sterelny's alternative. I begin, in section 2, by briefly sketching the background debates that motivate the GCC models that Sterelny critiques. I then layout those models, focusing on Henrich and Boyd's (2002) formal model of prestige biased transmission. In sections 3 and 4, I detail and respond to Sterelny's three main objections to the GCC account of cultural accumulation.

1. Challenging the Meme Conditions while affirming Cultural Evolution

Sterelny considers three basic views of cultural evolution: memetics, dual inheritance, and GCC. A key dividing line between the GCC view of cultural change and the other two views is that they are committed to the similarity of genetic and cultural transmission. They

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[2] See also Grayon (2005) for a philosophical classification of current approaches to cultural evolution.
[3] The basic theory stresses two main points: (i) that "culture is crucial for understanding human behavior" and (ii) that "culture is part of biology" (Richerson and Boyd, 2005, 3-4). Boyd and Richerson argue that for culture to evolve humans need a host of psychological adaptations for acquiring, managing, improving, and transmitting information within their groups. They hold that while culture evolves, it does not do so in isolation from the evolution of biological adaptations that allow for it.

generally endorse what I will refer to as the *meme conditions*[4], holding that information

transmission is generally accurate, discrete, and vertical (flowing from parents to offspring). In

contrast, the GCC view explicitly challenges the necessity of these conditions for cumulative

evolution.[5] They deny that the accumulation of beneficial cultural variants (high quality

information or cognitive capital) depends on a gene-like flow of information across the

generations.

      To show this, GCC theorists have developed a number of formal mathematical models

that illustrate how culture could accumulate under different assumptions. Sterelny focuses on

two types of models in GCC work, each of which emphasizes a different mechanism of cultural

transmission. The first type includes those models that are driven by a learning mechanism of

conformity bias; learning decisions are modeled in terms of a psychological predisposition for

individuals to copy more prevalent variations on a local practice. While Sterelny does not

specify what model of this type he has in mind, we are directed to Boyd and Richerson (1985).

These models directly challenge the assumption that cultural transmission must be highly

accurate or predominantly vertical. Conformity bias assumes oblique transmission (non-vertical

transmission across generations or trans-generational transmission outside of direct kin

relationships) and shows that inaccuracies in transmission do not necessarily lead to the loss of

cultural knowledge.

      If models of conformity bias are taken to give a full theory of cultural evolution, then a

significant problem arises: Accounting for *preservation* is not to account for *accumulation*. As

Sterelny notes, the spread and preservation of common knowledge is unlikely to lead to

cumulative improvements in that knowledge exactly because the mechanism of conformity bias

works to preserve the common and not the novel. He takes the second type of model to be a

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[4] See Dawkins, 1976, 1982; Dennett, 1995; Blackmore, 1999.
[5] See Henrich, Boyd, and Richerson, 2002, for a detailed discussion.

response to this failure; it differs from the initial model by introducing a mechanism of *preferential learning bias*. The basic idea is that novel, beneficial information could increase in a population if it were preferentially copied, even if copying is non-vertical and error prone. Sterelny focuses on one variation on this idea, the formal model of *prestige biased transmission* given by Henrich and Boyd (2002).

Before turning to Sterelny's treatment of Henrich and Boyd's model, it is best if their work is put into some further context. GCC work is marked by its use of formal mathematical models. The number of different models used is far larger than Sterelny's discussion would suggest; for example, Boyd and Richerson's 1985 volume alone presents 38 distinct models. Not surprisingly, these models are *not* treated as individually constituting full-fledged theories (as Sterelny's critique also seems to suggest). Rather, they are conceived of as *tools* that facilitate the development and testing of theories (see Henrich and Boyd, 2002, 88, for example).

Henrich and Boyd's article uses three formal models for the express purpose of challenging the claim put forward by Sperber (1996), Atran (2001, 2002), and Boyer (1994, 1999) that "selective processes do not usually generate adaptive cultural evolution" (2002, 89). The landscape for this debate is somewhat involved. Simplifying a bit, the starting point is the assumption of the meme conditions – that for evolutionary explanations of cultural adaptation to apply, cultural information must be discrete and accurately replicated during transmission. This involves two claims: That the meme conditions hold and that their holding is necessary for cultural evolution to occur. Sperber, Atran, and Boyer deny the first claim while accepting the second. They argue that cultural information is not discrete, that its transmission is not accurate, and that it is not replicated vertically but is recreated in an inferential process. The denial of these conditions is then taken to show that cultural adaptation is not the result of an evolutionary process. While Henrich and Boyd concur that the meme conditions do not necessarily hold

(although this is an empirical matter), they firmly deny that this logically implies that culture does not evolve (90). Each of the three models they present is given to draw out this point; the third model, which Sterelny focuses on, assumes that the meme conditions do not hold, but nonetheless shows that cultural evolution can occur through a mechanism of prestige biased transmission.

In prestige biased transmission individuals preferentially learn from those with high status (prestige serving as an indicator of information quality). To model this formally, Henrich and Boyd greatly simplify on actual social learning interactions, ignoring the economic complexities that are detailed in Henrich and Gil-White's (2001) work on prestige biased transmission. The key variables in the model are the individuals in the population (N), the quality of their information (z), and the chance that they will be selected as a cultural model (their prestige, f). The goal, is not to give a full theory, but to show that culture can evolve (that z-values can increase over time) even when information transmission is inferential and error-prone. Information transmission is captured in terms of the mimic's z-value being updated with an inaccurate (inferential) copy of the model's. Inaccuracy in transmission is captured in two ways: The mimic never exactly replicates the model's information (its z-value is always different); further, the copied information tends to be of lower quality – the mimic's z-value is, on average, lower than the model's (104-5).

Despite these rather strong constraints, the model shows that cumulative adaptive evolution is possible. In fact, "no matter how poor individuals are at imitating, there are some [conditions]… that generate cumulative evolution" (107). While the model is a greatly simplified tool, the results nonetheless indicate that cumulative evolution need not be tied to the meme conditions.

2. Sterelny's Objections

While Sterelny considers the GCC models to be partially successful, he feels that "the Boyd-Richerson line does not fully resolve the paradox of cultural accumulation" (151). His critique centers on three primary objections that he raises against the Henrich-Boyd model: He challenges the conception of skill found in the model; he challenges the ability of individuals to accurately recognize information quality; and (most importantly) he challenges the economic feasibility of the learning exchanges modeled. I consider and respond to each objection in turn.

2.1 The Conception of Skill

Sterelny argues that Henrich and Boyd's model involves a conception of skill that is psychologically implausible:

> They model the information structure underlying a capacity or skill as a continuous quality. Now the product of a skill may often be a quantity of some kind: Hunting success; the robustness of a pot; the power of a bow. But the systems of information and skill on which those products depend are not continuous quantities. (146)

This is doubtless correct, but for a trivial reason – systems of information or skill are not *quantities* (whether continuous or discrete); the information must be *evaluated* or *measured* to be represented quantitatively (just as pots are not continuous quantities even though their "robustness" can be evaluated quantitatively on a continuous scale). As we saw above, the formal model captures skill in terms of a single variable, the z-value. This variable does not directly represent the "underlying informational basis" (146n) of a skill, as Sterelny claims, but is a *measure* of the information's quality; the z-value is a quantitative measure of the individual's skill, not a representation of her actual information. As Henrich and Boyd put it, the z-value "measures the individual's skill in some domain like canoe making, arrow manufacture or

medicinal plant selection" (104). The claim that the z-value is psychologically implausible

seems to stem from confusion over what it represents in the model.

2.2 The Recognition of Skill

Sterelny's second objection questions the plausibility of the mechanism of a preferential

learning bias that is central to the extended model. His objection largely stems from his

treatment of this mechanism as equivalent to a "copy the best" learning strategy (147): He

articulates the model in terms of mimics preferentially copying "the *most successful* agent (or

agents) of the previous generation" or the "generation master" (146; italics added). Rendered in

this way, for the strategy to be an option individuals must be able to accurately determine what

the *best* information is. Sterelny's argument targets this last point: a preferential copying bias

will be "an accessible strategy only if the best is *markedly* better than the rest" (147). If the best

information is not readily recognizable as such, if it is only a minimal improvement over

common knowledge for example, then the applicability of a copy the best strategy is

questionable.

Sterelny's emphasis on the *best* is subtly at odds with the general GCC treatment,

however. It is not necessarily the *most successful* individuals who are copied, but "more

successful individuals" (Henrich and McElreath, 2003, 130); not necessarily the *best* information

but merely the "better-than-average" (Henrich and Gil-White, 167). In like fashion, Henrich and

Boyd's third model employs a *copy the better* strategy, not a *copy the best* strategy. While they

"assume that all learners *attempt* to copy the most skilled individual" (104; italics added), they

do not assume that learners are invariably successful.[6] As a model of *prestige biased*

transmission, the Henrich-Boyd model distinguishes between information quality and the

selection criteria that mimics use in choosing a cultural model. In prestige biased transmission

individuals preferentially copy *prestigious* cultural models because prestige "provides a

convenient and reliable proxy for that person's information quality" (Henrich and Gil-White,

2001, 167); such a proxy measure is not expected to be completely accurate.

The formal model captures this distinction between information quality and prestige by

separating an individual's *z*-value (information quality) from her *f*-value (prestige). While these

values are related (prestige being a reliable proxy for skill), they are not identical and other

factors besides *z*-value can affect an individual's *f*-value (104). The most prestigious individual

may not be the one with the best information. As such, Sterelny's objection misses its target: He

argues that the best "mimics can hope to do is copy one of the good, and the Henrich-Boyd

model does nothing to show that this learning rule will convert small, lucky overshoots of the

model's technique into a platform for further improvement" (147); but, this is, in fact, exactly

what the model does show.

The results of the Henrich-Boyd model are not necessarily intuitive, however, and this

presumably fuels Sterelny's argument. At base, Sterelny seems to hold that a copy the better

learning strategy will let too many information improvements slip through the cracks for

progressive evolution to occur. He is correct that under such a strategy many (perhaps even

most) information improvements will be lost. Nonetheless, his intuitions go wrong in assuming

that this means that culture could not accumulate. Selection does not need to be perfect for

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[6] The reason for this assumption is not stated, but presumably it is made for the sake of economic simplicity.
Henrich and Gil-White (2001) note that "clients can shop around for the model offering the best copying 'deal' (a
function not only of information quality, but of price of access…)" (170). While such economic considerations are
essential to the larger information goods theory that Henrich and Boyd's third model supports, these considerations
are extraneous to the stated purpose of the formal model (to "show that prestige biased transmission *can* lead to
cumulative adaptation, even when cultural transmission is inaccurate and representations are not discrete" (104;
italics added)).

progressive evolution to occur. To see this, note that Sterelny's objection could also be applied

to genetic evolution. Most beneficial mutations are only minimal improvements and nature

offers no guarantee that they will survive in the gene pool. Most of these improvements will be

lost, but a lucky few will survive and spread through the population. This is sufficient for

cumulative evolution to occur.

2.3 Gaining Access to the Skillful

For someone to pursue a copy the better learning strategy it isn't enough for them to

recognize high quality information, they also need to be able to gain access to it. Sterelny's

second objection targeted information recognition, his third objection targets information access.

He raises doubts about the economic viability of the oblique learning exchanges found in the

Henrich-Boyd model, suggesting that oblique transmission of high quality information is not

generally in the economic best interest of teachers (that it is not economically feasible for them).

The broad structure of Sterelny's argument is that the GCC explanation of cultural accumulation

is caught in a pincer of its own devising. On the one side, GCC theorists explain the evolution of

social learning in terms of its being cheaper than individual learning, while on the other side

Henrich and Gil-White's work "undermines the idea that culturally acquired information is

typically cheap" (150). To avoid this dilemma, Sterelny argues that GCC theory needs to be

supplemented, that "the mechanism on which Boyd and Richerson rely are effective only if

cultural group selection is powerful" (141).[7] He holds that cultural group selection explains the

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[7] The meaning of "group selection" and "cultural group selection" are not always clear in the literature (for example, contrast Elliott Sober and David Wilson's (1999) treatment with Boyd and Richerson's (2005)). My response to Sterelny's argument, however, does not rely on the specifics of his account of group selection: He calls on it to explain the altruism he locates in oblique teaching; I deny that oblique teaching is altruistic in the first place, thereby undercutting Sterelny's call for cultural group selection – whatever its details or validity.

evolution of altruistic teaching which lowers the costs involved in social learning and thereby shows how it can be cheap despite the plausibility of Henrich and Gil-White's account.

The first side of the pincer consists in the general GCC account of why cultural information exchange has evolved. GCC theorists argue that learning from others is often cheaper than figuring something out for yourself – that "cultural transmission is adaptive because it saves learners the costs of individual learning" (Henrich and Gil-White, 2001, 167). The basic point is that reinventing the wheel is typically a waste of resources and in some cases is downright perilous.[8] Avoiding such costs is held to be of obvious benefit to the individual, and this forms the backbone of the GCC account of the evolution of social learning. Sterelny does not deny this account, but holds that on its own it only explains the evolution of *vertical* social learning, not the *oblique* transmission found in Henrich and Boyd's model.

The second side of the pincer builds on Henrich and Gil-White's information goods theory. Sterelny takes their work to show that oblique social learning is not cheap, and argues that this undercuts the GCC explanation of why oblique social learning occurs. The basic idea is that high quality information is valuable; it is an asset that potential teachers can (and should) charge a price for. Sterelny holds that while "this picture is plausible" (150) it undermines the basic assumption of the first side of the pincer (that social learning is beneficial because it is cheap). This objection is specific to *oblique transmission*, or trade with non-relatives. In vertical social learning exchanges parents have non-economic motivation for passing their high quality information on to their children.

Putting the two sides of the pincer together, Sterelny argues that oblique social learning would only occur if it was cheap for students, that this is economically unrealistic, and thus that it is paradoxical that oblique transmission is seemingly ubiquitous (149). He responds to this

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[8] As Sterelny notes, "the cost of error can make the price of [individual] trial and error learning very expensive indeed: imagine sampling what turns out to be poisonous to see whether it is edible" (Sterelny, 2006, 148).

paradox by hypothesizing that cultural group selection pressures have driven the costs of oblique learning down: "the costs to individuals are partially compensated by benefits that accrue to human social groups rather than to individuals alone" (148). The primary group benefit that Sterelny discusses is information backup. Oblique transmission (in addition to vertical transmission) disseminates novel information farther than vertical transmission alone could, thus further insulating it from loss.[9]

Sterelny's argument rests on the claim that oblique teaching is not (generally) economically feasible for the teacher. This leads him to associate oblique transmission with group selection, while individual selection accounts for vertical transmission: "individual selection will favour vertical transfer, *perhaps modified by a market in information*. It will do so because vertical transfer preserves individual advantages within the groups." (155; italics added). If such a "market in information" can explain oblique transmission in terms of individual level decisions, however, then Sterelny's argument fails. I argue below that this is in fact the case.

3. The Market in Information

In this section I argue that oblique transmission is explicable in terms of rational individual level decisions in the information marketplace. I do this by elaborating on Joseph Henrich and Francisco Gil-White's (2001) information goods theory. I hold that their work not only does not support Sterelny's argument (as the basis of the second side of the pincer), but in fact undermines it.

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[9] As Sterelny puts it: "Skills crucial to the group are less likely to be lost with oblique transfer. If pot-making or fire-starting is transmitted only in one or a few family lineages in the group, unlucky accidents can deprive the group as a whole of these skills…. If not very many people possess a skill, the chance of losing it is surprisingly high." (156).

I will not offer a full defense of Henrich and Gil-White's theory here.[10] For current

purposes, it is sufficient to merely note the plausibility of their view. It seems to be the case that

information can often be both beneficial to the possessor and transmitted to others (social

learning). This appears sufficient to warrant preliminary reasoning in terms of an information

economy. As Henrich and Gil-White argue, "because of our unique social learning capacities,

humans can trade an asset that most other species cannot: directly acquirable information" (191).

They explicate information trade in terms of prestige or status. Prestige benefits the individual in

a number of ways; for example, the prestigious individual might be excused from various social

obligations (182). Information forms *cognitive capital* that can be exchanged for *prestige* or

deference. Such cognitive capital is an *indirect benefit* of having high quality information; it

comes from trading the information rather than the *direct benefits* that come from its use. To

evaluate the economic feasibility of an information exchange, both types of benefits need to be

taken into account. To simplify matters, I will discuss both in terms of the same generic shared

currency.

The basic response to Sterelny's third objection is that it does not adequately evaluate the

economics involved in oblique teaching. Sterelny's argument charges that oblique transmission

is economically altruistic because otherwise information would be prohibitively expensive. This

flies in the face of typical economic thinking, however. Far from being generally expensive, we

should expect that information goods, like tangible goods, will run the gamut from cheap to

expensive and that the price for a given good will largely depend on the *supply* of it coupled with

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[10] Specifically, I will not compare the merits of an "information goods" theory to competing views of the
development of non-agonistic status, such as the "tangible goods" hypothesis that has been put forward in
evolutionary psychology (see, for example, Patton, 2000; Pinker, 1997; Tooby and Cosmides, 1996). The primary
difference between these theories is in what is traded for status: under the tangible goods hypothesis, tangible goods
(food, tools, etc.) are traded for deference; under the information goods hypothesis this is expanded to include trade
in information. The evolution of status/prestige is an interesting question. Nonetheless, relative to Sterelny's
problem of interest, what matters here is that information can be traded for prestige (not whether such exchanges
helped drive the evolution of prestige).

the *demand* for it. Information goods will not be uniformly expensive, although high quality, uncommon information might be. Such information will be expensive because its *high quality* is likely to sponsor high demand, while being *uncommon* means that it has a *low supply*.

High demand coupled with low supply is a recipe for high prices: Teachers will be "highly motivated to impose a price" (Sterelny, 2006, 150) *and* students will be equally motivated to pay a price. The teacher's motivation is tied to that of the students since the teacher cannot impose what the students will not pay. The student's motivation is in obtaining the valuable (high quality, uncommon) information. How expensive this information will be will largely depend on what the market will bear; if, for example, the information is easy to recreate (to learn without purchasing), then its price will drop. Recreation will increase supply while decreasing demand, driving prices down. Sterelny's argument is built on oblique learning being expensive *relative* to individual learning; but, information will only be expensive when individual learning is costly or difficult and this will often tip the scales in favor of oblique learning.

3.1 Having your Cake and eating it too

The above reasoning holds for any sort of goods. Information goods, however, have some unique features in comparison with tangible goods: Unlike simply possessing a cake (a tangible good), knowing how to bake a cake (an information good) means that you can have your cake and eat it too. Unlike tangible goods, information goods are not used up in passing them on. Unlike selling a tangible good, in selling information the seller does not lose the asset but creates a copy of it. This means that an information good can be both used and sold – that it can simultaneously be an asset both directly and indirectly. For those who are able to partake in the

indirect benefits of teaching their high quality information[11], it will often behoove them to do so since teaching the information does not prevent them from also using it; the indirect benefits come on top of the direct benefits – they are the frosting on the cake, as it were.

Because one can have one's cake and eat it too, we should expect that oblique exchange of information goods will be correspondingly more likely to occur than for tangible goods (because the seller is giving up less). Of course, trade in tangible goods is ubiquitous and does not seem to be driven by altruistic selling; it is likewise not at all paradoxical that oblique transmission of information goods is ubiquitous. Sterelny's motivation for postulating altruistic teaching falters and with it the reason for supplementing the GCC models with cultural group selection pressures.

4. Conclusion

Gene-culture coevolution theory is a fascinating, multi-level approach to explaining certain aspects of human evolution. Unfortunately, it has not received the sort of philosophical attention that it deserves. While Sterelny's article is important in bucking this trend, the objections he raises against the GCC account of cultural accumulation are not convincing. Ultimately, his first two objections rest on a misunderstanding of the model that he critiques, while the third fails to adequately consider the economic pressures expected in an information marketplace.

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[11] Possessing information, including the ability to use it, does not necessarily imply the ability to teach it; for example, being able to read does not imply skill in teaching reading to others. The reverse is also possible; for example, consider the arthritic piano teacher who is now more adept at teaching than at playing.

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