

**How much of language, if any, came about
in the same sort of way as the brooding chamber in snails?**

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1. Introduction

The rough comparisons below point to the core ideas of four among the more interesting modern conceptions of the genesis of human language.

- (1)(a) Human language arose like the brooding chamber in certain snails.
- (b) Human language originated like birds' feathers.
- (c) Human language evolved like the vertebrate eye.
- (d) Human language came into existence like a snowflake.

These four conceptions differ from one another primarily over the nature of the process that is seen as central to the genesis of language. In (1)(a), it is a process of "cooptation"; in (1)(b), one of "preadaptation" or "function shift"; in (1)(c), one of "adaptation"; and in (1)(d), one involving one or more "physical forces".

The present paper is the first in a series whose aim it is to assess critically the merits and limitations of these four conceptions of language genesis. This paper focuses on the conception that language, like the brooding chamber in certain snail species, came about through cooptation as a by-product of something else.

The snails of these species protect their eggs by using what Stephen Jay Gould (1997a, p.10753) calls an "umbilical brooding chamber".¹ This chamber is a cylindrical space inside a coiled tube; the tube is laid down in a coil as the snail body grows. The chamber and the coil have the same geometric axis. Evolutionarily speaking, this central space did not arise as part of a design selected for the advantages of egg protection – indeed, no such design ever

existed. Rather, the space arose nonadaptively, as a by-product of a biological process of the winding of a tube around an axis.

Various scholars, including Noam Chomsky (1982a, 1988, 1991), Stephen Jay Gould (1991), Massimo Piattelli-Palmarini (1989, 1990) and Lyle Jenkins (2000), have proposed that language or some fundamental feature(s) of language arose nonadaptively like the brooding chamber in snails. On such a conception, language or some of its features – it should perhaps be stressed – emerged initially as a consequence or by-product of something else. Chomsky's (1982a) speculation on the matter instantiates this point clearly. Taking it that humans' capacity to deal with discrete infinities is fundamental to the computational component of language, he has speculated that–

"... it could, for example, be a consequence of the increase in brain size and complexity". (Chomsky 1982a, p. 22)

Such conceptions of the origin of either language or some of its features will be referred to below as "by-product conceptions of language origin" or, more briefly, "by-product conceptions".

The by-product conception of language origin held by Chomsky and Gould has been dismissively criticized as a view characterized by "vacuity" (Pinker and Bloom 1990, p. 711), as being "utterly implausible" (Newmeyer 1998, p. 313), as being "more an *ex cathedra* proclamation than a theory" (Donald 1999, p. 138) and so on. The proponents of this conception have shown no sign of abandoning it, however, at least not in public. This gives rise to questions such as the following:

- (2)(a) What are the general conditions of adequacy which any by-product conception of the emergence of a biological entity should meet?
- (b) To what extent are these conditions met by the by-product conception of language origin held by Chomsky and others?
- (c) If this by-product conception has any limitations, are these of an accidental kind or of the in-principle kind?
- (d) How forceful are the main criticisms of this by-product conception?

In taking up these and related other questions, the present paper aims to offer an even-handed appraisal of Chomsky's by-product conception of language origin. The specific background to this appraisal will be Gould and Vrba's (1982) theory of exaptation, which includes a theory of evolutionary by-producthood. These theories are outlined in para. 2 below. Para. 3 deals with the question of the grounds on which the status of evolutionary by-product can or cannot be assigned to a particular biological entity or feature. Chomsky's by-product conception of language origin is critically analysed in para. 4; Gould's defence of it is considered in para. 5. Para. 6 assesses the force of some of the main criticisms of the by-product conception of language origin advocated by Chomsky and Gould. In conclusion, the question of what conditions any by-product conception of language origin should meet in order to merit serious consideration is discussed in para. 7.

Before turning to Gould and Vrba's theory of exaptation, it is necessary to clarify the way in which the term "conception" is used in this paper as part of the expression "conception of language origin". A conception C of something S is taken here to differ from a theory T of S in two basic ways: (i) in regard to the specifics of what it asserts about S, C is less fully articulated than T; and (ii) C is more highly speculative and less directly testable than T. In the sense intended, therefore, a conception of S is both in ontological and in epistemological terms a less fully developed construct than a theory of S². In the literature, the expressions "view" and "viewpoint" are often used as synonyms of "conception" in the sense just stipulated.

2. A theory of by-producthood

Claims to the effect that a particular biological entity or a feature of such an entity arose nonadaptively as a consequence or by-product of something else presuppose a general theory of evolutionary by-producthood.³ Such a theory has to state the conditions under which an entity or feature may be properly assigned the evolutionary status of by-product. These conditions, moreover, will determine the kinds of evidence and forms of argument that can be properly used in justifying claims which attribute by-product status to entities or features of entities. In the absence of an adequate theory of by-producthood, claims to the effect that specific entities or features arose as by-products would be ad hoc and arbitrary.

The most fully developed theory of evolutionary by-producthood forms part of Gould and Vrba's (1982) theory of exaptation. In their attempt to account for large-scale evolutionary change, Gould and Vrba (1982, pp. 4–6) draw a distinction between two categories of characters that enhance fitness.⁴ The first category is the adaptations: characters shaped (or built) for their present use (or function) by natural selection. As instances of "true adaptations", Gould (1991, p. 47) cites the elaborate plumages and behavioural displays of male birds of paradise; the function of these characters is to help ensure the males' success in mating. Like the character shaped, the evolutionary process that shaped it is called an "adaptation". The second category of fitness-enhancing characters is the exaptations: characters that enhance fitness in their present role but that, according to Gould (1991, p. 46), were not built for this role (or effect) by natural selection. The evolutionary process by which an exaptation arose is called an "exaptation" or "cooptation".

Exaptations belong on Gould and Vrba's (1982, pp. 5–6) theory to one of two subcategories. The first comprises the characters previously shaped as adaptations by natural selection for a particular function but coopted later for a new use (or effect). An example given by Gould and Vrba (1982, p. 7) is that of feathers which evolved initially as an adaptation for thermoregulation and were later coopted for flight. The process of exaptation by which exaptations of this subcategory originate is referred to as "preadaptation" by some and "function shift" by others.⁵

To the second subcategory of exaptations, Gould and Vrba (1982, pp. 5–6) assign characters that did not originate by the direct action of natural selection and that were later coopted for a current use (utility, role or effect). The umbilical brooding chamber of snails referred to in para. 1 above instantiates the second subcategory of exaptations. Characters belonging to this subcategory have been called "spandrels"; "spandrels" is a term borrowed by Gould and Lewontin (1979) from architecture, where it designates forms and spaces that arise as necessary by-products of another decision in design, and not as adaptations for direct utility in themselves. On Gould's (1997a, p. 10751) judgement, "spandrel" is "optimally suited" as a general term in evolutionary biology for "the concept of a nonadaptive architectural by-product of definite and necessary form – a structure of predictable size and shape that then

Within their general theory of exaptation, Gould and Vrba (1982, p. 11) provide for two other concepts that will prove to be useful from to the analytical concerns of the present paper: "primary exaptations" and "secondary adaptations". In their basic design, feathers are primary exaptations for flight, having evolved by adaptation for insulation. Once this new fitness-enhancing role in flying was added to the function of thermoregulation, feathers underwent what Gould and Vrba call "a suite of secondary adaptations" or "post-adaptations", which enhanced their utility in flight. In the view of Gould and Vrba (1982, pp. 11–12), the evolutionary history of any complex feature is likely to include a "sequential mixture of adaptations, primary exaptations and secondary adaptations". The reason why such secondary adaptations happen is that any exapted or coopted structure "will probably not arise perfect for the new role".

3. Identifying evolutionary by-products

Determining whether a given structure or feature is to be assigned or denied the evolutionary status of by-product or spandrel is a complex matter for Gould:

"... if we now have available only the modern structure with its mix of primary adaptations and secondarily exapted spandrels – the usual situation in biology when we do not have a fossil record of actual historical stages leading to a present structure – then how can we identify and allocate the proper statuses? After all, both types of features may now be exquisitely well 'crafted' for a current utility – for the exapted spandrel may work just as well, and may be just as crucial to current function of the whole, as the primary adaptation." (Gould 1997a, p. 10752)

To make the matter more complex still, there is the possibility that by-products or spandrels may have been subject to a suite of the secondary adaptations referred to at the end of para. 2. So what are the grounds – general considerations and kinds of evidence – that can be properly invoked in assigning or denying a "modern structure" the status of evolutionary by-product or spandrel? In addressing this question, Gould (1997a) uses the term "spandrel" rather than "by-product", a terminological practice without any deeper significance.

First, there are some considerations which in Gould's view cannot be used as grounds for assigning or denying a structure S the status of (biological) spandrel. These include–

- (3)(a) the extent to which S is well-crafted for a current utility,
- (b) the nature of the current utility (role or effect) of S,
- (c) the evolutionary meaning or importance of S,
- (d) the (physical) size of S.

As for (3)(a), Gould believes, we have seen, that a structure which originated as a spandrel through primary exaptation may have been further "crafted" for its current utility by a "suite of secondary adaptations". Consequently, it may end up being "exquisitely crafted for its current utility" and may work just as well as an adaptation. How well crafted S is or how well S works, accordingly, cannot be used as a ground for assigning or denying S the status of a structure that originated as a spandrel.

Turning to (3)(b), Gould (1991, p. 45) has insisted that "the clear separation of historical origin and current utility" is an important "conceptual tool" of the evolutionary biologist.⁷ In his view, the inference of origin from current utility constitutes a "false conceptual passage".⁸ The nature of the current utility of S accordingly does not provide a basis for assigning or denying spandrel status to S.

As regards (3)(c), a ground related to (3)(b), Gould (1991, pp. 54–55, 1997a, p. 10754) rejects what is referred to as the "sequelae argument". In terms of the sequelae argument, spandrels always occur later than and secondarily to primary adaptations, as "correlated consequences" of them, and never as "active phenomena themselves" or as "important components of a structural design". Gould (1997a, p. 10745) rejects these views because "manner of origin has no necessary relationship to the extent or vitality of a later coopted role". And he (1991, p. 55) emphasizes that "[t]he important issue is not status at origin, but later evolutionary meaning; the last shall be first, and the correlated consequence may emerge as the directing feature". A notable implication here is that the status of spandrel cannot be withheld from S on account of its being an important component in the structural design of a more complex entity.

Concerning (3)(d), Gould (1991, p. 55, 1997a, pp. 10753–10754) rejects the "Nooks and Crannies Argument" as well. In terms of this "argument", spandrels are "just funny little spaces" left over after the major features of form and behaviour have been shaped by

adaptation. By analogy with the (architectural) spandrels of the San Marco Cathedral, Gould (1991, p. 55) offers two observations in rebuttal of this "argument" about (biological) spandrels. First, spandrels can be "spatially extensive" whatever their "temporal status".⁹ Second, the "design" and "secondary utilization" of spandrels may "feed back" into the evolutionary process and thereby "determine major features of the entire structure".¹⁰

Which brings us to two grounds that Gould (1997a, pp. 10752–10753) does accept for the purpose of assigning or denying a structure S the status of spandrel. These are

- (4)(a) historical order and
- (b) comparative anatomy.

As for (4)(a), it involves the use of historical evidence to determine for two features, F_1 and F_2 , which one arose first as a primary adaptation and which one subsequently as a coopted by-product. If available, evidence of this kind would, for example, provide an answer to the question "Did the umbilical brooding chamber of snails arise as a nonadaptive geometric by-product of winding a tube around an axis or did it evolve as part of an actively selected design centered upon the direct advantages of protecting eggs in a cigar-shaped central space?" Since there is no historical evidence bearing on this question, we do not know according to Gould (1997a, p. 10753) whether the first coiled snails brooded their eggs in an umbilical chamber. In the case of a large number of structures or features, the use of what Gould (1997a, p. 10753) calls the "method of actual historical sequence" is ruled out by the lack of historical evidence.

As regards (4)(b), in the absence of historical evidence about what actually happened in the evolution of a particular structure or feature, biologists draw inferences about its evolution from evidence about comparative anatomy. Such evidence is obtained by tabulating the comparative anatomy of current examples of the structure or feature in question in a cladistic context and by subsequently trying to determine a historical order from the distribution yielded by such tabulation.¹¹ The use of what Gould (1997a, p. 10753) calls the "method of comparative anatomy" yields evidence that bears on the question of the evolutionary status of the brooding chamber in linguists. Specifically, 2006, p. 48 of this method reveals that, whereas

thousands of species of snails have umbilical spaces, only a few use this space for brooding. In addition, the "umbilical brooders" occupy only a few tips on distinct late-arising twigs of the evolutionary tree in question and not a central position near its root. From these two observations, it may properly be inferred according to Gould (1997a, p. 10753) that the umbilical space under consideration had arisen as a spandrel and then became coopted for later utility in only a few lines of brooders.

Gould sees the "method of actual historical sequence" as "evidently superior" to the "method of comparative anatomy" since the former relies on "raw observations rather than inferences". The use of the latter method, moreover, is limited in a fundamental way: it can only be used in the case of structures or features where cladistic comparison is possible. This means that this method cannot provide evidence bearing on the evolution of structures or features which are (believed to be) specific to a particular species. The comparison has to involve homologous structures or features, of course, rather than analogous ones.¹²

Notice that neither of the grounds on which a structure or feature can be assigned spandrelhood according to Gould applies to human language. As regards (4)(a), since there is no direct historical evidence about the events through which language originated, Gould's "method of actual historical sequence" cannot be used to determine whether language did or did not arise as a spandrel or by-product. As for (4)(b), scholars who believe that language is specific to the human species cannot use the "method of comparative anatomy", even in a suitably adapted form, in the case of language since the belief that language is species-specific rules out the cladistic comparison required by this method.

Gould's theory of spandrelhood can, in conclusion, play an indirect but nevertheless important role in determining the process(es) by which language initially arose. This role is indirect in the sense that Gould's theory does not articulate grounds that can be invoked in assigning or denying language the status of spandrel. The theory's role, however, is important in that it serves as an example of the kind of theory which is required for assigning or denying evolutionary by-product status to human language or some of its features in a principled and properly argued way.

4. Chomsky's by-product "speculations"

Over the years, Chomsky has speculated more than once about the possibility that a fundamental feature of the language faculty originated as a by-product.¹³ And, in equally speculative terms, he has expressed the view that the human number faculty or capacity arose as a by-product likewise. Below, we will consider these two sets of speculations in turn.

4.1. *The language faculty*

Language is believed by Chomsky (1988, p. 169) to have a property that is "extremely unusual, possibly unique" in the biological world, the property of discrete infinity. This property is essentially involved in the fact that each sentence of a natural language has a fixed number of words, yet there is no limit to how many words a sentence may have. Referring to this property as a "capacity", Chomsky stresses the evolutionary significance of its emergence by observing that "[w]ithout this capacity it might have been possible to 'think thoughts' of a certain restricted character, but with the capacity in place, the same conceptual apparatus would be freed for the construction of new thoughts and operations such as inference involving them, and it would be possible to express and interchange these thoughts". (Chomsky 1988, p. 170)

On the origin of this property of discrete infinity, Chomsky offers what he terms "some speculations, nothing more", including the following:

"It may be that at some remote period a mutation took place that gave rise to the property of discrete infinity, perhaps for reasons that have to do with the biology of cells, to be explained in terms of physical mechanisms, now unknown." (Chomsky 1988, p. 170)

Here is a first question that arises about these speculations: What is discrete infinity a by-product of? Chomsky has responded to this question in the most general of terms only. Thus, referring to the property of discrete infinity alternatively as "a system of discrete infinity" and a "computational capacity to deal with discrete infinities", he has speculatively pointed to increased size and complexity of the evolving brain as possibly the feature of humans that

"It [i.e., the capacity to deal with discrete infinities – R.P.B.] could, for example be a consequence of the increase in brain size and complexity." (Chomsky 1982a, p. 22)

"It could be that when the brain gets so complex, it simply has to encompass systems of discrete infinity." (Chomsky 1982a, p. 23)

"In this regard [i.e., that of the origin of an infinite digital system – R.P.B.], speculations about natural selection are no more plausible than many others; perhaps these are simply emergent physical properties of a brain that reaches a certain level of complexity under the specific conditions of human evolution." (Chomsky 1991, p. 50)

These speculations clearly have nothing specific to say about the way(s) in which human brains became so big and/or complex that discrete infinity resulted as a by-product. Where Chomsky does appear to furnish some specifics with the aid of such expressions as "more cortical surface" and "hemispheric specialization for analytic processing", he qualifies his further speculations to such an extent that it is unclear how they could be tested. Consider in this regard the following example (all emphases added):

"These skills [e.g., learning a grammar and recognizing faces – R.P.B.] **may** well have arisen as a concomitant of structural properties of the brain that developed for other reasons. **Suppose** that there was selection for bigger brains, more cortical surface, hemispheric specialization for analytic processing or many properties that **can be imagined**. The brain that evolved **might** well have all sorts of special properties that are not individually selected; there would be no miracle in this, but only the normal workings of evolution." (Chomsky 1982b, p. 321)

A second question that arises concerns the factors that were responsible for the brain's attaining the size and complexity of which discrete infinity is a consequence. Chomsky is equally nonspecific about these factors. He mentions factors involving the biology of cells (Chomsky 1988, pp. 168–169), unknown physical laws relating to neuron packing or regulatory mechanisms (Chomsky 1980, p. 100, 1988, p. 169), and constraints on growth and form related to the ones proposed by D'Arcy Thompson (Chomsky 1982a, p. 23). But he makes no detailed claims about how these factors were either individually or collectively

A third question concerns the nature of Chomsky's justification of his by-product conception of language origin. What he has said in this regard does not ground the speculations under consideration in a principled theory of by-producthood. For instance, Chomsky (1988, p. 168, 1982a, p. 22) has observed that discrete infinity is "extremely unusual" and "possibly unique", but has not tried to show that these properties are diagnostically significant within the framework of some theory of by-producthood. It is therefore doubtful whether this observation yields evidence that supports the attribution of by-product status to discrete infinity.¹⁴ Curiously, Chomsky has done more towards justifying his speculation that the human number faculty is an evolutionary by-product. What Chomsky has had to say on the origin of the number faculty actually highlights the absence of specifics that is so marked in his by-product conception of the origin of the language faculty, a point that will be fleshed out in the next paragraph.

4.2 *The number faculty*

In Chomsky's (1988, pp. 168–169) view, humans are the only species which has what he alternatively refers to as a "number faculty", a "number capacity" and a "number system" whose most elementary property is that of discrete infinity: "the series of numbers goes on indefinitely; you can always add one more" (Chomsky 1988, p. 168). As regards the origin of the number faculty, Chomsky (1988, p. 168) finds it "impossible to believe that it was specifically selected for". The reason why he cannot believe this is that "cultures still exist today that have not made use of this faculty". The fact that this faculty was latent and unused for almost all of human history means, in Chomsky's opinion, that it did not bestow any selectional advantage on humans.¹⁵

On how the number faculty did "develop", one "can only speculate" at this point, according to Chomsky (1988, p. 169). And he has offered two main speculations about this development. In the first, the number faculty is assigned the evolutionary status of a "by-product":

"... it is possible that the number faculty developed as a by-product of the language faculty." (Chomsky 1988, p. 169)

¹⁴In the second speculation, however, Chomsky assigns the number faculty the status of an abstraction.
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"... we might think of the human number faculty as essentially an 'abstraction' from human language, preserving the mechanism of discrete infinity and eliminating the special features of language." (Chomsky 1988, p. 169)

Chomsky offers two grounds for this second speculation. First, if the number faculty were an abstraction of the language faculty, that would explain on his (1988, p. 169) view "the fact that the number faculty is available though unused in the course of human evolution". Second, it would also explain why humans have two faculties which are both "quite unusual and perhaps even unique in the biological world".

Which brings us to the question of how the two speculations quoted above are interrelated. Concretely, this is the question whether (5)(a) and (b) express one and the same claim about the origin of the number faculty:

- (5)(a) The number faculty developed as a by-product of the language faculty.
- (b) The number faculty is an abstraction from human language.

At issue is whether a by-product and an abstraction are the same kind of thing from an evolutionary perspective. On Gould's theory of by-producthood, a structure S can be a by-product of something else E without being an abstraction of E in Chomsky's (1988, p. 168) sense of a version "preserving the mechanism of E and eliminating the special features of E". And, indeed, not a single of the examples of spandrels discussed by Gould, Vrba and Lewontin is an abstraction in Chomsky's sense from the entity from which it was exapted.

The root of the problem is that Chomsky makes the claims (5)(a) and (b) without offering a theory which explicitly states conditions on evolutionary by-producthood or abstraction status. This is why these claims are ad hoc and obscure in regard to content. It is moreover the absence of such a theory that makes it difficult to judge whether the considerations adduced by Chomsky for (5)(a) and (b) are appropriate and sufficiently strong. If these considerations were of the right sort, one would expect Chomsky to take them into account, in a suitably adapted form, when expounding the idea that the language faculty is a by-product. He has not,

The following consideration is, for example, used by Chomsky to argue against the idea that the number faculty evolved by natural selection:

- (6) If a faculty is available but unused in the course of human evolution, it could not have evolved through natural selection.¹⁶

Chomsky, as we noted above, takes it to be a fact that the number faculty was latent and unused for almost all of human history and that even today there are cultures that have not made use of it. And, as we noted, these facts can be "explained" by assigning the number faculty by-product or abstraction status. If Chomsky set about the question of assigning faculties a particular evolutionary status in a principled way, one could have expected him to extend the use of consideration (6) from the number faculty to the language faculty. If he did this, two routes would be open to him. On the first route, he would have to address questions such as the following: Was the language faculty available but unused in the course of human evolution? Does the language faculty bestow a (significant) selectional advantage on humans? Are there even today cultures that have not made use of the language faculty? Taking the other route, Chomsky could have given reasons why consideration (6) and the questions associated with it do not apply to the language faculty. But he has not proceeded along either of these two routes.

Consider, finally, the way in which Chomsky has used the concept of "abstraction" in parallel to that of "by-product" to characterize the evolutionary status of the number faculty. The question arises as to why Chomsky has not also used the "abstraction" concept in characterizing the evolutionary status of the language faculty. And why he has refrained from considering questions such as: What entity could the language faculty be an abstraction from? What is the mechanism that was preserved in abstracting the language faculty from this entity? What are the special features that were eliminated in abstracting the language faculty from this entity? Alternatively, Chomsky could have made a principled case for not using his "abstraction" concept for capturing the evolutionary status of the language faculty. This line of thinking about the origin of the language faculty presupposes a clearly articulated theory of evolutionary by-producthood or abstraction status. It is the absence of such a theory which makes Chomsky's by-product conception of language origin ad hoc and minimal in what it speculatively claims. And it is the absence of such a theory which makes Chomsky's mode of

approach to the origin of the language faculty hard to reconcile with his mode of approach to the origin of the number faculty.¹⁷

5. Gould's "translation"

As part of his argument for considering the concept of "exaptation" a "crucial tool" for evolutionary psychology, Gould (1991, pp. 61–62) shows how it can be used for giving an account of "fundamental attributes" of humans, including human language. Fundamental attributes, in his view, are attributes which are unique to the human species. Gould rejects the "adaptationist and Darwinian tradition" of constructing scenarios in terms of which language grew in a gradual and continuous way out of gestural and calling systems of other species. Instead, he opts for Chomsky's conception of the origin of language; this, on Gould's (1991, p. 61) "translation" claims that "language is an exaptation of brain structure". This conception of the origin of language ties in with Gould's (1991, p. 57) view that "for something so complex and so replete with latent capacity as the human brain, spandrels must vastly outnumber original reasons, and exaptations of the brain must greatly exceed adaptations by orders of magnitude".

On the matter of the faithfulness of his "translation" of Chomsky's conception of the origin of language, Gould observes that—

"Chomsky, who has rarely written anything about evolution, has not so framed his theory, but he does accept my argument as a proper translation of his views into the language of my field – Chomsky, personal communications". (Gould 1991, p. 61)¹⁸

Gould, moreover, offers some justification of the "translated" Chomskyan view that language is an exaptation of brain structure rather than an "adaptationist continuation" of an attribute of some other species. This justification is interesting both for what it does and does not include.

The justification mixes fact-like considerations with ones of a rhetorical sort. A first fact-like consideration involves "the spectacular collapse of the chimp experiments" which Gould (1991, p. 62) takes to weaken the adaptationist position that cross-species continuity exists in the case of language origins. Gould agrees that cross-species continuity must exist in the case of the growth of conceptual powers and rhetorically asks—

"... but why should our idiosyncratic capacity for embodying much of this richness in the unique and highly peculiar mental structure called language be seen as an expression of this continuity?" (Gould 1991, p. 62)

For later reference, the properties of language involved in the first fact-like consideration adduced by Gould in support of the claim that language is an exaptation of brain structure can be stated as (7)(a) and (b):

- (7)(a) idiosyncratic, peculiar nature, and
- (b) uniqueness in the species or species-specificity.¹⁹

As a second fact-like consideration supporting the claim in question, Gould (1991, p. 162) asserts that the "traits" attributed by Chomsky (1986) to language "fit far more easily with an exaptive, rather than an adaptive explanation". These "traits", in Gould's (1991, p. 62) phraseology, are—

- (8)(a) "universality of generative grammar";
- (b) "lack of ontogeny (for language 'grows' more like a programmed organ than like memorizing the kings of Engeland)";
- (c) "highly peculiar and decidedly non-optimal structure";
- (d) "formal analogy to other attributes, including our unique numerical faculty with its concept of discrete infinity".

Having listed these "traits" of language, Gould observes once more that, in becoming large for whatever reason, the brain acquired a "plethora of cooptable features". And he appends two rhetorical questions to this observation:

"Why shouldn't the capacity for language be among them [i.e., the plethora of cooptable features – R.P.B.]? Why not seize this possibility as something discrete at some later point in evolution, grafting upon it a range of conceptual capacities that achieve different expression in other species (and in our ancestry)?" (Gould 1991, p. 62)

These rhetorical questions conclude the justification offered by Gould (1991) for the claim that language is an exaptation of brain structure.

The question that now arises about this justification is: Just how good is it, given Gould's own theory of what exaptations in the sense of spandrels are and given his own methodology for determining whether a specific structure or feature should or should not be assigned the status of spandrel? An essential weakness of this justification lies in what is omitted from it: Gould fails to make any reference in it to the former theory or the latter methodology. On the one hand, he considers neither the question of whether the grounds (4)(a) and (b) should or could be invoked in attributing spandrelhood to language nor the question of what the most appropriate method would be for determining whether language is or is not a spandrel. On the other hand, he does not go into the question of why the properties (7)(a)–(b) and (8)(a)–(d) should be taken as distinctive of, criterial for or, more weakly, indicative of spandrelhood. This is curious since none of these properties is explicitly accorded such a status in Gould's theory of spandrelhood. His use of these properties is, in short, ad hoc and arbitrary in terms of his own theory of spandrelhood.

Superficially, one of the latter properties, namely that of species-specificity, seems to be related to a property that is pertinent to the use of the "method of comparative anatomy". Within the framework of this method, we have seen in para. 3 above, the fact that a structure or feature is used by just a few of the species to which it is available is taken to be evidence of the spandrel status of this structure or property. It could now be contended that the fact that a structure or feature such as language occurs in one species only represents the strongest manifestation of the phenomenon of restricted use or spread and thereby constitutes a ground for assigning spandrel status to it. This line of argument, however, would be flawed in that it fails to take into account the distinction between the intraspecies and the interspecies distribution or occurrence of a structure or property. The fact that a particular structure or property is species-specific seems to be of methodological significance only: the evolutionary status of such a structure or property cannot be determined with the aid of the "method of comparative anatomy".²⁰

In conclusion: Gould's attribution of spandrel status to human language will remain ad hoc and arbitrary until such time as the properties (7)(a)–(b) and (8)(a)–(d) are accorded the status

of "distinctive" or "indicative of spandrelhood" on principled grounds in terms of his own theory of exaptation.²¹

6. Questionable criticisms

Chomsky's by-product conception of language origin has been criticized in the literature for what are obviously considered to be severe shortcomings. Pinker and Bloom (1990), for example, hold that this conception exhibits the following flaws:

- (9)(a) As for Chomsky's idea that language emerged as a consequence of the application of physical laws, there isn't "any reason to believe that there are as yet undiscovered theories of physics that can account for the intricate design of natural language". (Pinker and Bloom 1990, p. 720)
- (b) Concerning Chomsky's idea that language emerged as a consequence of constraints on its possible neural basis and epigenetic growth,
- (i) "[t]he space of physically possible neural systems can't be all that small as far as computational abilities are concerned"; and
 - (ii) "... it is most unlikely that laws acting at the level of substrate adhesion molecules and synaptic competition, when their effects are projected upward through many levels of scale and hierarchical organization, would automatically result in systems that accomplish interesting engineering tasks in a world of medium-sized objects." (Pinker and Bloom 1990, p. 721)
- (c) As regards Chomsky's idea that language emerged as a consequence of the large size attained by human brains,
- (i) there are studies showing that "mere largeness of brain is neither a necessary nor a sufficient condition for language ...". (Pinker and Bloom 1990, p. 721); and
 - (ii) "... there may be direct evidence against the speculation that language is a necessary physical consequence of how human brains can grow." (Pinker and Bloom 1990, p. 721)

Newmeyer (1998), in turn, has criticized Chomsky's by-product conception of language origin for such failings as the following:

- (10)(a) "I find a Thompsonian/spandrel explanation for the design features of any significant aspect of the language faculty to be utterly implausible. The hexagonal cell aggregate, the equiangular spirals, and so on found repeatedly in nature, and determined by the same laws of physics that suggest optimal design for a bridge or the arrangement of packing crates, have no counterpart in the language faculty. Indeed, perhaps the most salient (and at times, frustrating) aspect of UG is its lack of symmetry, the irregularity and idiosyncrasy that it tolerates, the widely different principles of organization of its various subcomponents and consequent wide variety of linking rules relating them". (Newmeyer 1998, p. 315)
- (b) "[Chomsky has defended the autonomy thesis according to which – R.P.B.] underlying linguistic behavior there is a separate component of our knowledge, which is not reducible to other forms of knowledge. But we have a contradiction here. UG cannot be derivative and autonomous at the same time. What are the chances of UG emerging as an automatic consequence of *any* set of external principles, but having an internal algebra totally independent of those principles. Absolutely none, I would venture to say." (Newmeyer 1998, p. 314)
- (c) "[Chomsky] wants, language, at one and the same time, to be an epiphenomenon and an 'organ', the latter by definition a product of a dedicated genetic blueprint. But it cannot be an 'organ', even in a metaphorical sense, if it is simply an inevitable consequence of a big brain." (Newmeyer 1998, p. 316)

Finally, consider as a third set of sample criticisms of Chomsky's by-product conception of language origin the following ones as (re)phrased by Aitchison (1994):

- (11)(a) "... this by-product view is highly unlikely, as language is too complex. Exaptation – a re-use of an existing structure – is undoubtedly a powerful force in evolution. But in all documented cases, complex structures are used for simple purposes, and not vice versa." (Aitchison 1994, p. 75)
- (b) "The complexity of language, and the interwoven adaptations of the mouth, larynx and brain make it unlikely that language could have developed as an accidental by-product." (Aitchison 1994, p. 75)

The criticisms (9)(a)–(c), (10)(a)–(b) and 11(a)–(b) of Chomsky's conception of language origin are intended, clearly, to be criticisms of substance. But how pertinent are they really? On closer inspection, these criticisms turn out to be less than well aimed, since they fail to observe a number of fundamental distinctions.

First, in accounts of the evolution of a biological entity (or structure), a distinction is standardly drawn between the entity as a whole and specific features or components of it. This distinction applies to language in the sense of the language faculty too, as has been observed more than once in the literature.²² Though Chomsky's conception of the origin of language is in various ways insufficiently clear and specific (as has been shown in para. 4 above), his speculations on the origin of the language faculty are on the whole underpinned by this distinction. In particular, what Chomsky has offered is a conception of a specific feature of the language faculty, namely discrete infinity. He has **not** offered this as a conception or theory of the evolution of the language faculty or Universal Grammar as a whole – as a whole that

- (12)(a) is characterized by "intricate design" (cf. (9)(a));
- (b) "accomplish[es] interesting engineering tasks" (cf. (9)(b)(i));
- (c) displays "design features" (cf. (10)(a));
- (d) is characterized by a "lack of symmetry", by "irregularity" and "idiosyncracies" (cf. (10)(a));
- (e) is characterized by "widely different principles of organization" (cf. (10)(a));
- (f) has an "internal algebra" (cf. (10)(b));
- (g) is too "complex" a structure to be used for "simple purposes" (cf. (11)(a)); and
- (h) is characterized by "complexity" that is "interwoven" with "adaptations of the mouth, larynx and brain" (cf. (11)(b)).

Chomsky's conception of language origin, in sum, cannot be properly criticized for failing to give an account of the evolution of the language faculty or Universal Grammar in its modern form. This conception should rather be criticized, if at all, for what it claims about the origin of discrete infinity as a fundamental feature of the language faculty.

Second, a distinction is standardly drawn between various phases in the evolution of a biological entity (or structure) or features of such an entity. These phases include those

referred to in the literature by such expressions as "origin", "emergence", "appearance in the initial form", "elaboration and complexification leading to the current form", "initial spread (in a population)", "maintenance (in a population)", "atrophy", "loss" and so on.²³ On the whole, Chomsky has phrased his conception of the origin of discrete infinity in terms referring to the very first evolutionary phase, namely that of "origin", "(first) emergence" or "initial appearance". The following remarks by him are typical in this regard:

"[An innate language faculty] poses a problem for the biologist, since, if true, it is an example of the 'emergence' – the appearance of a qualitatively different phenomenon at a specific stage of complexity of organization". (Chomsky 1972, p. 70)

"It may be that at some period a mutation took place that gave rise to the property of discrete infinity ..." (Chomsky 1988, p. 70)

Chomsky does provide for further phases in the evolution of the language faculty in which the process of natural selection played a role:

"In some cases it seems that organs develop to serve one purpose and, when they have reached a certain form in the evolutionary process, became available for different purposes, at which point the process of natural selection may refine them for further purposes ... Possibly human mental capacities have in some cases evolved in a similar way" (Chomsky 1988, p. 167)²⁴

But Chomsky has not offered his conception of language origin as a theory of how the language faculty evolved through any noninitial phases into its modern form.²⁵ Criticisms such as (9)(a)–(c), (10)(a)–(c) and (11)(a)–(b) are wrong, therefore, to construe this conception as a theory of the latter sort. To be pertinent, these criticisms have to pinpoint flaws in Chomsky's by-product speculations on how discrete infinity originated or appeared in the first phase of the evolution of the language faculty. Interestingly, the critics in question do not seem to have the conceptual means that are required for criticizing Chomsky's attribution of by-product status to discrete infinity. Specifically, they seem to lack a principled theory of evolutionary by-producthood in terms of which they can question, in a non-ad hoc and sufficiently well-argued way, Chomsky's speculations on the by-product status of discrete infinity as a feature of the language faculty. In Gould's (1997a, p. 10752) terminology, this

means that these critics themselves are not able to "identify and allocate the proper statuses" in the conceivable event that the language faculty, as a "modern structure", is a "mix of primary adaptations and secondary exapted spandrels."²⁶ The fact that critics of Chomsky's by-product conception of language origin fail to ground their criticisms of it in a principled theory of evolutionary by-producthood, obviously, does nothing at all to remedy the shortcomings identified in para. 4 above. And questioning the pertinence of these criticisms is in no way a defence of this conception of Chomsky's. The point, simply, is that the flaws of a conception of language origin cannot be laid bare by appraising it as if it were a theory of the evolution of the complexified modern language faculty as a whole.

7. Conclusion

Let us, in conclusion, consider the question of the minimal conditions of adequacy which have to be met by by-product conceptions of language origin. From the discussion above, it has emerged that a central condition among these is that of theoretical embeddedness: no by-product conception of language origin can be adequate unless it is embedded in a principled theory of evolutionary by-producthood. A conception that fails to meet this condition cannot assign or deny by-product status to a linguistic entity or feature in a non-ad hoc and non-arbitrary way. To date, no by-product conception of language origin which meets this condition has been proposed. This means that we simply don't know how much of language, if any, came about in the same sort of way as the brooding chamber in snails.

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NOTES

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1. Gould's succinct account of the properties and evolution of this brooding chamber is based on work done by Lindberg and Dobberton.
2. A distinction should also be drawn between a theory of language origin (or some other phase of language evolution) and a more inclusive account of language origin (or some other phase of language evolution). For this distinction, see Botha (2001).
3. In the literature the terms "entity", "structure", "system" are used loosely as synonyms in this context, as are the terms "feature", "trait", "property" and "character".
4. Griffiths (1992, p. 117) observes that Gould and Vrba offer two different characterizations of (an) exaptation, one of which represents a "fundamental confusion". What follows below is not affected by this observation, if correct.
5. Some scholars have found the term "preadaptation" problematic because it could be taken, incorrectly, to imply foreordination. For some discussion of this misunderstanding, see Gould and Vrba (1982, p. 11), and Shelley (1999, pp. 65–66).
6. The use of the term "spandrel" in this context has been criticized on various counts. For a rebuttal of some of these criticisms, see Gould (1997a, 1997b).
7. For this point, see Gould and Lewontin (1979, p. 153) and Gould and Vrba (1982, pp. 5–6, 7) as well.
8. Gould (1991, p. 45) illustrates this "principle" with the aid of the following example: "We all understand this principle in the case of human artifacts: No one would claim that the U.S. Mint made dimes thin so that all Americans could carry surrogate screw-drivers in their change purses".
9. To illustrate this point, Gould (1991, p. 55) observes that the pendentive supports of a dome mounted on arches may cover more area than the dome itself.

10. In Gould's (1991, p. 55) view, San Marco offers a good example of this because mosaic decorations on the radially symmetrical central domes are designed in four-part

symmetry, in clear harmony with the four pendentives below. The design of the main structure is thus determined by both the form of the spandrels and their number.

11. A clade is a set of species descended from a common ancestral species (Ridley 1993, p. 632). Cladistic analysis is analysis of the derived characters of organisms to infer the branching sequence in phylogeny based exclusively on derived characters (Mayr 1997, p. 306). And a cladogram is the inferred branching pattern of a phylogenetic tree (Mayr 1997, p. 306).
12. A homologous structure or character is one which (a) is shared by a set of species, and (b) is present in the common ancestor of these species (Ridley 1993, p. 636, Mayr 1997, p. 308). An analogous structure or character is one which (a) is shared by a set of species but (b) is not present in the common ancestor of these species (Ridley 1993, p. 631).
13. In these speculations, Chomsky has used the term "language" as a synonym for "language faculty". See Botha (1997, pp. 256–257) for some discussion of the (non-)distinction drawn by Chomsky (and others) between "language" and the "language faculty".
14. This point will be further pursued in para. 5 below.
15. An earlier formulation of this idea reads as follow: "This is a capacity that could not have been specifically selected, because it was never overt until human evolution reached essentially its present stage" (Chomsky 1982a, p. 20).
16. In Chomsky's (1988, p. 168) view, it is not the case that people who could count or solve problems of arithmetic or number theory were able to survive to produce more offspring. Wynn and Bloom (1992, p. 410) maintain that "the capacity to count" evolved in animals as an adaptation through the process of natural selection.
17. There appears to be another inconsistency in Chomsky's thinking about the origin of the language faculty. In some formulations – for example, some of those represented above – he portrays the process by which discrete infinity originated as a property of the language faculty as one that may be characterized in Gouldian terms as "spandrel cooption". In other formulations, however, he depicts this process as (possibly) one of function-shift: "In some cases it seems that organs develop to serve one purpose and, when they have reached a certain form in the evolutionary process, became available for different purposes, at which point the processes of natural selection may refine them further for

these purposes. It has been suggested that the development of insect wings follows this pattern. Insects have the problem of heat exchange, and rudimentary wings can serve this function. When they reach a certain size, they become less useful for this purpose but begin to be useful for flight, at which point they evolve into wings. Possibly human mental capacities have in some cases evolved in a similar way." (Chomsky 1988, p. 167)

18. A problematic aspect of Gould's "translation" is that, whereas it attributes to Chomsky a certain view of the origin of "language", Chomsky's by-product conception of language origin is a conception of one fundamental feature of language, namely discrete infinity, only.
19. See also Gould (1993, p. 321) for the importance he assigns to these properties.
20. See also Pinker and Bloom (1990) for this point.
21. Piattelli-Palmarini (1989, 1990) has outlined an exaptationist conception of language origin which in essential ways is similar to Gould's.
22. For some references and discussion see Sober (1990, p. 764), Botha (1997, pp. 259–260).
23. See Griffiths (1992, pp. 124–126) for a characterization of some of these phases. Botha (1997, pp. 260–261) shows how the failure to draw a principled distinction between certain phases of language evolution is one of the factors making for a lack of focus in the discussion of Pinker and Bloom's (1990) selectionist theory.
24. For some clarification of the role accorded by Chomsky to the process of natural selection in language evolution, see Botha (1998, p. 231–234).
25. In Botha (1998, p. 228–231) it is argued that Chomsky has not proposed what may be properly called a "theory of language evolution".
26. Recall that Gould (1997a, p. 10752) has argued that both types of features may in their modern form be "exquisitely well 'crafted'" for a current utility.

REFERENCES

- Aitchison, J., 1994. *The Seeds of Speech. Language Origin and Language Evolution.* Cambridge University Press, Cambridge.
- Botha, R.P., 1997. Neo-Darwinian accounts of the evolution of language: 1. Questions about their explanatory focus. *Language and Communication* 17, 249–267.
- Botha, R.P., 1998. Neo-Darwinian accounts of the evolution of language: 4. Questions about their comparative merit. *Language and Communication* 18, 227–249.
- Botha, R.P., 2001. On the role of bridge theories in accounts of the evolution of human language. *Language and Communication* 21, 61–71.
- Chomsky, N., 1972. *Language and Mind. Enlarged Edition.* Harcourt Brace Jovanovich, New York.
- Chomsky, N., 1980. *Rules and Representations.* Columbia University Press, New York.
- Chomsky, N., 1982a. *The Generative Enterprise. A Discussion with Riny Huybregts and Henk van Riemsdijk.* Foris Publications, Dordrecht.
- Chomsky, N., 1982b. Discussion of Putnam's comments. In: *Language and Learning: The Debates between Jean Piaget and Noam Chomsky*, (Ed.) M. Piattelli-Palmarini. Routledge and Kegan Paul, London, pp. 310–324.
- Chomsky, N., 1986. *Knowledge of Language: Its Nature, Origin and Use.* Praeger, New York.
- Chomsky, N., 1988. *Language and Problems of Knowledge. The Managua Lectures.* MIT Press, Cambridge, MA.
- Chomsky, N., 1991. Linguistics and cognitive science: problems and mysteries. In: *The Chomskyan Turn*, (Ed.) A. Kasher. Basil Blackwell, Oxford, pp. 26–53.
- Donald, M., 1999. Preconditions for the evolution of protolanguages. In: *The Descent of Mind. Psychological Perspectives on Hominid Evolution*, (Eds.) M.C. Corballis, S.E.G. Lea. Oxford University Press, Oxford.
- Gould, S.J., 1991. Exaptation: a crucial tool for evolutionary psychology. *Journal of Social*

- Gould, S.J., 1993. *Eight Little Piggies. Reflections on Natural History.* Penguin Books.
- Gould, S.J., 1997a. The exaptive excellence of spandrels as a term and prototype. *Proc. Natl. Acad. Sci. USA* 94, 10750–10755.
- Gould, S.J., 1997b. Letter to the *New York Review of Books*, 9 October, 1997, 56–58.
- Gould, S.J., Lewontin, R.C., 1979. The spandrels of San Marco and the Panglossian paradigm: a critique of the adaptationist programme. *Proceedings of the Royal Society of London* 205, 581–598.
- Gould, S.J., Vrba, E.S., 1982. Exaptation – a missing term in the science of form. *Paleobiology* 8, 4–15.
- Griffiths, P., 1992. Adaptive explanation and the concept of a vestige. In: *Trees of Life. Essays in Philosophy of Biology*, (Ed.) P. Griffiths. Kluwer Academic Publishers, Dordrecht/Boston/London, pp. 111–131.
- Jenkins, L., 2000. *Biolinguistics. Exploring the Biology of Language.* Cambridge University Press, Cambridge.
- Mayr, E., 1997. *This is Biology. The Science of the Living World.* The Belknap Press of Harvard University Press, Cambridge, MA.
- Newmeyer, F.J., 1998. On the supposed 'counterfunctionality' of Universal Grammar: some evolutionary implications. In: *Approaches to the Evolution of Language*, (Eds.) J.R. Hurford, M. Studdert-Kennedy, C. Knight. Cambridge University Press, Cambridge, pp. 305–319.
- Piattelli-Palmarini, M., 1989. Evolution, selection and cognition: From "learning" to parameter setting in biology and the study of language. *Cognition* 31, 1–44.
- Piattelli-Palmarini, M., 1990. An ideological battle over modals and quantifiers. *Behavioral and Brain Sciences* 13, 752–754.
- Pinker, S., Bloom, P., 1990. Natural language and natural selection. *Behavioral and Brain Sciences* 13, 707–727, 765–784.
- Ridley, M., 1993. *Evolution.* Blackwell Scientific Publications, Boston.
- Stellenbosch Papers in Linguistics, Vol. 33, 2000, 21–48
- Shelley, S. 2004. Preadaptation and the explanation of human evolution. *Biology and Philosophy* 14, 65–82.

Sober, E., 1990. Anatomizing the rhinoceros. *Behavioral and Brain Sciences* 13, 764–765.

Wynn, K., Bloom, P., 1992. The origins of psychological axioms of arithmetic and geometry.

Mind & Language 7, 409–416.