

Pointing and the Evolution of Language: An Applied Evolutionary Epistemological Approach

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ABSTRACT

Numerous evolutionary linguists have indicated that human pointing behaviour might be associated with the evolution of language. At an ontogenetic level, and in normal individuals, pointing develops spontaneously and the onset of human pointing precedes as well as facilitates phases in speech and language development. Phylogenetically, pointing behaviour might have preceded and facilitated the evolutionary origin of both gestural and vocal language. Contrary to wild non-human primates, captive and human-reared nonhuman primates also demonstrate pointing behaviour. In this article, we analyse the debates on pointing and its role it might have played in language evolution from a meta-level. From within an Applied Evolutionary Epistemological approach, we examine how exactly we can determine whether pointing has been a unit, a level or a mechanism in language evolution.

KEYWORDS: Applied evolutionary epistemology, Evolutionary linguistics, Units, Levels, Evolutionary mechanisms, Pointing.

1. Introduction

During the last decennia, scholars from a variety of disciplines, including psychology, primatology and (evolutionary) linguistics, have demonstrated an increasing interest in pointing. Three reasons for this tendency can be given.

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For one, although cultural differences have been reported, index-finger or canonical pointing appears to be universally present in humans. Several scholars (Tomasello, 2000; Butterworth, 2003, 14–16; Kita, 2003; Povinelli, Bering, & Giambrone, 2003) have therefore suggested that index-finger pointing is a universal human trait that, to some extent, might also be biologically determined.

Secondly, the pointing behaviour extends the purely physical and behavioural domain because it is often associated with communicative behaviour, such as vocalizations and gaze alternations (Povinelli, Bering & Giambrone, 2003, p. 38), or the first and two-word phase (Butterworth, 2003, p. 28; Masataka, 2003, pp. 72–74; Goldin-Meadow & Butcher, 2003); as well as cognitive behaviour such as intentionality (Tomasello, 2000, 2004; Tomasello & Call, 1997), or problem solving (Leavens, 2004; Leavens, Hopkins, & Bard, 2005, 2008).

Finally, in natural settings nonhuman primates apparently do not point while captive apes do. Significant differences can be detected in the pointing behaviour of captive apes who are merely institutionalized (in e.g. zoos or medical research centres), and apes who have been home-reared or language-trained. Especially within the latter group, declarative pointing is part of the behavioural repertoire, while institutionalized apes only display imperative pointing (Leavens, 2004; Leavens, Hopkins, & Bard, 2005). Tomasello (2000, 2003, 2004; Tomasello & Call, 1997) therefore defines pointing based upon the presence or absence of intentionality. The latter however, is a motivational state that is hard to be proven to be present on a scientific, observational level. And Leavens (2004, pp. 390–392) therefore proposes instead that pointing is defined as “an act of nonverbal reference”. Leavens, Hopkins, & Bard (2005) also counter the idea that pointing is a biologically determined trait. Instead, they provide evidence that it are ecological, epigenetic factors, such as an inability to move freely in space, that results in the emergence of pointing behaviour in both humans and captive apes. They therefore argue that pointing, as an adaptive behavioural response to environmental conditions, is a type of problem-solving behaviour.

2. What Inferences Can We Draw from Pointing Studies on Language Evolution?

Pointing is one of the behaviours that is widely studied in both our species and others and the results of these studies therefore lend themselves perfectly for a thorough analysis of how the behaviour might be implicated in human language evolution. Its ontogenetic association with certain milestones in human language development, and the fact that pointing behaviour is also displayed by captive apes makes adherents of both a gestural as well as vocal origin of language assume that pointing is one of the first non-verbal communicative acts that humans evolved towards language. Pointing, as an act of nonverbal reference, is easily imitated and pointing facilitates gestural as well as vocal communication. Pointing might therefore also facilitate the origin of language during a proto-linguistic, proto-lexical phase (Arbib, Liebal, & Pika, 2008; Corballis, 1992; Jackendoff, 1999; Zlatev, Persson & Gärdenfors, 2005; Zlatev, 2008). But how can we move beyond mere assumptions and prove such a claim to be correct?

For something to evolve rather than to originate *de novo* during many generations of individuals, that something must form an entity or unit, whereupon evolutionary mechanisms can be active, and a locus or level must exist where these evolutionary mechanisms can act on these levels. If we want to identify pointing as a behaviour relevant for the evolution of language, we have to be able to identify the evolutionary mechanisms whereby pointing evolved, and the level or locus where such an evolutionary process took place.

Applied Evolutionary Epistemology (AEE) (Gontier, 2010b, 2012) is a scientific and philosophical methodology that enables one to identify phenomena under study as either a unit, level or mechanism of evolution. It combines the tenets of Evolutionary Epistemology (Gontier, 2006; Gontier, Van Bendegem & Aerts, 2006) with the research methodologies associated with Universalizing Evolutionary Theory. In regard to natural selection theory, Evolutionary Epistemologists (Campbell, 1974, 1997; Hull 1981), Philosophers of Biology (Brandon 1982) and Evolutionary Biologists (Lewontin 1970) have engaged in abstracting universal heuristics or "skeletons" of the selection mechanism to enable the evolutionary study of sociocultural phenomena; and they have engaged in contemplating the nature of units and levels of selection. Applied Evolutionary Epistemology combines

both approaches and applies them to phenomena and biological theories not addressed by the founders of the Modern Synthesis.

Pointing is indeed such a behaviour not addressed by the classic evolutionary biologists who argued that the phenotype as a whole, or only genes evolve. Pointing provides us with a very complex behavioural repertoire, that, if present under similar conditions across and within species over long periods of time, must somehow be an outcome of evolutionary processes.

Which role pointing played in the evolution of language, and how pointing might be seen as a causal factor in the evolutionary origin of language is presently unknown. This is partly due to the complexity of the pointing behaviour. Pointing is a heterogeneous behaviour that is displayed differentially according to different physiological and ecological factors. It is present under different circumstances in humans and other primate species. It is a purely physical behaviour that is enabled by a series of motor activities, but it also appears to correlate with cognitive, emotional and linguistic behaviour. Sometimes, pointing is highly specifically defined (e.g. canonical pointing), sometimes it is very broadly defined (to include e.g. foot pointing, full-hand, middle finger or lip pointing, Wilkins, 2003, pp. 174–180). This also means that pointing itself is a theoretical concept that, according to the definition given, differentially groups several (sub)behaviours. As such, the investigation of the evolution of pointing might even be worth an independent study and this kind of evolution might then be implicated in the evolution of language. Primatologists, linguists, psychologists, etc. might profit from the act of understanding pointing as a kind of evolution, just as “language evolution”, or “the evolution of life” is a kind of evolution.

Secondly, because pointing is heterogeneously defined and the physical pointing behaviour itself is made up of several components, one must regard pointing as a behaviour dividable into several subunits. And pointing might be regarded as a superunit and this superunit might be implicated in the origin of language. The evolution of pointing might turn out to be part of the evolution of language (as a unit, level, or mechanism), but additionally, it might also turn out to be involved in the evolution of cognition, ToM, problem-solving, culture, etc.

How then, did (all these types of) pointing evolve? By which mechanisms, and at which loci? And how and when did it influence the evolution of language? Is pointing a unit of language evolution? Or a level where nonverbal communication can emerge and become the target of evolutionary

mechanisms? Or is pointing itself a mechanism that enables nonverbal and verbal communication? At present, we don't really know. Our top priority is therefore to try and answer these questions.

Following an applied evolutionary epistemological approach, it is suggested that one tries to identify pointing as either a unit, level or mechanism of language evolution. AEE follows 3 simple heuristics, discussed at length in Gontier (2010a, 2010b) that explains how one can identify a phenomenon as either a unit, level, or mechanism. In what follows, we apply these heuristics to pointing and investigate whether pointing is or is not a unit, level or mechanism in language evolution.

3. Is Pointing a Unit in Language Evolution?

Because pointing combines so many different behaviours, we can call it a superunit, that is decomposable into subunits. We will only be fully able to examine the role pointing had in language or any other kind of evolution if all its subunits are identified; if we know how all of these subunits interact to form a superunit; and if we have a clear view on how this agglomeration of units evolved (i.e. at what levels and according to which evolutionary mechanisms these subunits and the superunit evolve). The latter data are not available yet, so what follows can only be of a tentative nature. Nonetheless, it is interesting to see what pointing, understood as a superunit, can possibly introduce into the field of evolutionary linguistics when it is framed in accordance with the Applied Evolutionary Epistemological approach. Table 1 outlines a set of research questions that allow one to identify, examine and evaluate how pointing might be a unit of language evolution.

3.1. Discussion of Table 1

3.1.1. The Question Mark Phase (1)

Pointing is, under certain circumstances, a behaviour displayed in several (but not all) primates, including humans. How many types of evolution this behaviour is involved in needs further investigation. It is associated with physiological (muscle movements, motor maps), behavioural, nonverbal referential/communicative (declarative and imperative pointing), and cognitive abilities (problem-solving, intentionality, ToM); as well as with

<p align="center">Table 1. Is pointing a unit in language evolution? (read from left to right and top-down)</p>			
?	1. Try to prove that pointing is a unit of language evolution (1 example suffices). Thus go to yes .		
YES	2. Where? At which level is pointing the subject of language evolution?	Not one level found? Pointing is not a unit, go to no .	
		One/multiple level(s)? Identify them all. (Justifies that pointing is a unit.)	How , by which evolutionary mechanism(s) did pointing evolve? Identify them all.
	3. Since when ?	When did pointing first originate in time and when did it become a unit of language evolution?	
	4. How does the pointing unit interact with other units?	Can this unit be divided into one or several subunits ? If so, are they also units in language evolution?	
		Can this unit be absorbed into one or several superunits ? If so, are they also units in language evolution?	
	5. Can this unit be regarded as a level and/or mechanism of language evolution?	? & yes: try and treat pointing as a level and/or a mechanism, go to level and/or mechanism .	
NO	7. Level and/or mechanism?	? or Yes: go to level and/or mechanism .	
		No: treat pointing as irrelevant for language evolution until proven otherwise.	

certain environmental circumstances (sociality, culture, emotionality, exogenous barriers). Physiology, behaviour, nonverbal communication, cognitive abilities, sociality, culture, etc. are all highly likely involved in language evolution (either as units, levels or mechanisms). It is however uncertain whether pointing is a direct or indirect unit of language evolution.

At present it is thus uncertain whether (aspects of) pointing is (are) a unit of language evolution. In such uncertain situations the heuristic recommends to try and prove that pointing is a unit in the evolution of language and thus to go to YES.

3.1.2. The Yes Phase (2–6)

Identifying Pointing as a Unit of Language Evolution: Where, at which Level, and How, by which Mechanism did Pointing Evolve? (2)

If it is indeed a unit in the evolution of language, pointing should evolve at one or multiple language evolution level(s), according to one or more evolutionary mechanism(s). Therefore, the first question that needs to be asked is where, at which level(s) the unit “pointing” evolves and how it evolves at that level (by means of which evolutionary mechanisms)?

Here again, the heterogeneous nature of “pointing” highly complexifies the problem. Not one but a series of behaviours are characterized as pointing and pointing can be divided into several subunits. All these subunits can evolve at several levels and according to several (different) evolutionary mechanisms.

When we evaluate the works of the above described authors, *possible* levels are: the genetic (if there are pointing gene complexes), the neuronal (if it is underlain by motor maps), the ontogenetic (if it is learned), the epigenetic/environmental, the cognitive (if it is a form of ToM), the socio-cultural, the nonverbal communicative and the linguistic level.

Identifying something as a unit of evolution implies that we not only identify the levels but also the mechanisms whereby this unit evolved. The heuristic therefore also asks by which mechanisms pointing possibly evolved at these various levels.

If there are genes implicated in pointing behaviour, it is likely that they, like other genes, are the result of random mutations that became the subject of natural selection or random drift.

If pointing evolves at the neuronal or cognitive level, again various mechanisms must be involved. Cognitive and neuroscientists however are only beginning to identify the various mechanisms involved in the evolution of the mind and the brain, and research on how pointing is neurologically underlain is therefore dependent upon progress made in these particular fields.

Pointing might also evolve anew, in each generation, at an ontogenetic level by individual learning mechanisms, formal or informal instruction such as observational learning, imitation, operant conditioning, classic conditioning, etc.

At the epigenetic/environmental level, pointing might evolve as an adaptive behavioural/problem-solving response, or mechanisms such as niche construction might be involved where caregivers for example create an environment that facilitates pointing behaviour.

If pointing evolves at the cognitive, cultural, linguistic or nonverbal communicative level, we again need to identify the mechanisms whereby pointing evolves at these levels. Here too mechanisms such as instruction, niche construction, and the ratchet effect might facilitate the evolution of pointing at these levels.

In other words, pointing can only be proven to be a unit of language evolution if scholars are able to scientifically demonstrate that pointing indeed evolved at either one or multiple of these levels by means of a certain evolutionary mechanism. Then, and only then, can we identify pointing as a unit in language evolution.

If we are not able to identify a level where pointing evolved, it cannot be a unit of language evolution and the heuristic advises to go to the no-phase (7).

On a meta-level, it becomes obvious how the heuristic is a genuine question-generating device. It is a search engine or, in other words, a unit, level and mechanism detecting device. The heuristic says when to begin research, when to stop investigating a certain research avenue, and what steps need to be taken to conduct research.

One superunit such as pointing can introduce a series of subunits (index-finger pointing, all fingers extended pointing, middle-finger pointing, etc), levels (e.g. the genetic, ontogenetic, cognitive, cultural level, etc.) and mechanisms (e.g. natural selection, the ratchet effect, niche construction, operant conditioning, etc.) of language evolution. Research on pointing therefore implicates, identifies and justifies the study of numerous phenomena that are possibly involved in language evolution which can then become studied in and of themselves as possible units, levels and mechanisms involved in the

evolution of language. In particular, studying pointing as a possible unit of language evolution implicates that it is worthwhile to study whether the genome, ontogeny, the environment, cognition, culture, non-verbal communication and verbal communication are levels of language evolution. In turn, this requires that all the latter are also studied as independent “kinds of evolution”. And, pointing alone justifies the study of how natural selection, drift, formal or informal instruction mechanisms (i.e. observational learning, imitation, operant conditioning, classic conditioning, etc.), spontaneous generation (i.e. individual learning), the ratchet effect, niche construction, the Baldwin effect, problem-solving, and epigenetics are mechanisms possibly involved in language evolution.

Another immediate consequence of the fact that several units, levels and mechanisms appear implicated in the evolution of pointing also generates a series of questions that up until now have not been raised enough by the evolutionary linguistic, evolutionary epistemological and evolutionary biological community. Namely, how is it possible that several mechanisms are active upon a unit at multiple levels? And how do the different evolutionary mechanisms simultaneously interact with each other in regard to the same unit? For example, how do niche construction, the ratchet effect and operant conditioning interact in regard to the evolution of pointing at the level of culture? Do these mechanisms compete, cooperate or co-evolve? And how do the different levels interact with each other in relation to the unit? These questions all require evolutionary epistemological and evolutionary biological answers and as such, they provide a challenge to the latter fields.

Examining Pointing as a Unit of Language Evolution (3–6)

Returning to the heuristic, once one has identified several levels of language evolution where the unit evolves according to different mechanisms, one has identified pointing as a unit in the evolution of language. In this stage of the heuristic, a series of questions are generated that allow one to systematically generate, constrain and evaluate this unit of language evolution. More specifically, the following epistemological questions are raised.

When Did Pointing Become a Unit in Language Evolution? (3)

The “since when” question, asks about the (single or multiple) origin(s) of the unit in time, both in the origin of language, as well as in the general course of evolution. It is important to distinguish between the latter two, because pointing might have already evolved in time (in e.g. other hominids) before language evolved.

Currently, an exact date for when pointing behaviour first originated cannot be provided. If there is a pointing-gene complex as postulated by Buttersworth and Tomasello, then the origin of this gene (complex) is fixed in time and once this gene is discovered one can trace it back to its origin as well as map how it spread throughout the human (or hominid) population. On the other hand, following Leavens’ and co-workers’ ideas on pointing, it is likely that pointing arose multiple times and continues to do so.

When the pointing behaviour first arose in time depends on the origin of the subunits, mechanisms and levels involved in pointing, as well as when they first got combined into the pointing behaviour. The curling of the fingers and the extension of the index finger might for example have evolve later as a clarification of the message (to for example distinguish it from mere hand extension in humans, which might be interpreted as a request to be held). Moreover, if pointing evolves spontaneously due to individual (e.g. as an “aha-erlebnis”); or collective, cognitive learning processes (e.g. the ratchet effect); or in relation to certain ecological or cultural settings (environmental and/or cultural niche construction); then pointing evolve(d)/(s) several times. In this case, it needs to be investigated when the conditions that enable pointing to arise were first present.

The date(s) can be further narrowed down as follows. It is a universal human trait, thus it arose (once or multiple times) in our species. Some of the subunits are already present in great apes, apes and monkeys (e.g. inspection of the environment with the index-finger). These primates are able to at least extend their arms or all their fingers (thus the physiology and motor maps required to do so need to have already evolved in these species).

Because it is unclear when pointing first arose, and when language evolved, it is also impossible to date when pointing became a unit in language evolution specifically. Nonetheless, the differences between human and non-human primate pointing, indicate that it might have first evolved in the hominid

lineage, and that it underwent further specialized evolution in the *Homo* lineage.

It might be a topic of discussion whether the curling of the fingers, opposable thumbs, and highly mobile thumbs are a requirement that already needs to be in place. If it is, one can eliminate the origin of canonical pointing in most non-human primate species, because they lack the fine motor abilities to point canonically. Paleo-anthropological, anatomical research can then be consulted to further narrow down the date.

On the other hand, one might ask whether hands are required for the pointing behaviour to evolve in time. Dogs for example, during their hunting activities, often point with one paw to their prey (a behaviour that was already described by Darwin). Is the latter a nonverbal referential/communicative behaviour? If so, the origin of pointing surpasses the origin of primates and millions of years are added to the timeframe when pointing possibly evolved, and when it became relevant in language evolution.

Timing the evolution of pointing and inquiring about the constancy of the unit, once it evolved, allows one to further specify and constrain which aspects of the pointing behaviour are actually involved in the evolution of language. More specifically, it allows to differentiate between those aspects that are genuine *units* in the evolution of language; those aspects of pointing that might be involved in *other kinds of evolution* (e.g. the evolution of problem-solving, ToM, intentionality, etc.); and which aspects of pointing are, at best, mere *windows* (Botha, 2006) on the evolution of language.

Examples of such windows are imperative or declarative, indexical or full-finger extended pointing both in institutionalized or language-trained apes as well as in currently living children. Neither these apes, nor these children were part of the initial situation in which language evolved. At best, they allow to draw inferences on the initial condition and as such they are windows on the evolution of language

How Does Pointing Interact with other Units of Language Evolution? (4)

This question again allows the identification of other units of language evolution because it asks whether or not pointing can be divided into subunits (e.g. index-finger pointing, foot pointing, etc.) and grouped into superunits (e.g. nonverbal behaviour, cultural behaviour etc.). These questions again allow one to further constrain as well as generate research avenues.

The following sub-units of the behaviour can be distinguished: Canonical pointing (which is further divided into the following units: index-finger extension, the curling of the fingers, the downward holding of the thumb, the extension of the arm), middle finger pointing, pointing with all fingers extended, foot pointing, imperative pointing, and declarative pointing.

Pointing might be part of superunits such as non-verbal referential behaviour, non-verbal communication, symbolic behaviour, problem-solving behaviour, intentional behaviour, cultural behaviour. These superunit(s) might also be units of language evolution in and of themselves, and the study of pointing therefore implicates, and validates an independent study of these phenomena as possible units of language evolution.

The independent investigation of each sub- and superunit will allow one to separate the irrelevant from the relevant ones and might also allow the identification of windows on language evolution. Many of these sub- and superunits in turn are likely to also be units in the evolution of culture, sociality, problem-solving, etc. and as such, the elements that make up the pointing behaviour are neither directly nor exclusively involved in language evolution.

When a possible superunit such as “cultural behaviour” is in turn investigated as a possible unit of language evolution, in its division into subunits, it will implicate a multitude of units, levels and mechanisms that are (possibly) involved in language evolution. As such, a rather simple behaviour such as pointing can provide the scientific justification for the introduction of a multitude of scientific research avenues in evolutionary linguistics. Problem-solving and symbolic behaviour can be implicated in the evolution of intentional behaviour, and all three can be implicated in the evolution of cognition. Symbolic behaviour, non-verbal and verbal communication are involved in the evolution of humans and perhaps also other hominins.

Pointing as a superunit (or theoretical concept) can also include: pointing in wild apes, pointing in home-reared apes, pointing in institutionalized apes, and pointing in humans. Also the pointing with the right hand, the presence of an audience, visual contact with the pointed object and the social partner (via eye gazing), attention-getting behaviour, attention-directing behaviour, persistence in attention getting behaviour and vocalisations, intentionality, etc. can be considered units in the (series of) behaviour(s) that are denoted as pointing.

How Relevant is Pointing for (Studies on) Language Evolution? (6)

The importance of the unit can be evaluated by asking about the relevance of the unit, both in the actual evolution of language as well as in theory formation on the evolution of language. This is done by asking whether pointing is necessary and/or sufficient for language to evolve.

Although many of the questions raised require further examination, pointing probably is neither sufficient, nor necessary for language to evolve. It is not sufficient, because we know that the evolution of language also requires the evolution of other anatomical and behavioural features such as the descent of the larynx, the evolution of Broca and Wernicke's area, and so forth.

Ontogenetically, pointing might facilitate certain aspects of language acquisition, as is demonstrated by studies that indicate significant correlations between babbling, the first and two word phases. But blind or physically impaired children are able to learn language, so pointing is not necessary to learn language. Whether the evolution of pointing was necessary for language to evolve phylogenetically, remains open for discussion. Nonetheless, this does not exclude the possibility that pointing has contributed and continues to contribute to the origin and evolution of language.

On a meta-level, research on pointing therefore is neither a necessary nor sufficient aspect of a theory on the evolution of language.

3.1.3. The No-Phase

If scholars are not able to identify pointing as a unit of language evolution, they are advised to examine whether it is a level and/or mechanism of language evolution. These possibilities are discussed during the next two heuristics (table 2 and 3).

3.2. Conclusion on Pointing as a Unit of Language Evolution

Implementing the unit-heuristic into pointing research has introduced a multitude of new research questions and avenues. As a philosopher, it is not my place to answer most of these questions. The unit heuristic generates a series of questions that are currently not addressed and that require rigorous scientific attention of the psychological, primatological or evolutionary linguistic community. This heuristic is designed to systematize, constrain, generate and evaluate phenomena such as pointing so that one can build

systematic theories on pointing and other phenomena and their role in the evolutionary origin of language. As such, it is amazing how the investigation of pointing as a possible unit of language evolution is able to generate as well as justify the investigation of a series of events, mechanisms and phenomena as possible units, levels and mechanisms of language evolution.

4. Is Pointing a Level of Language Evolution?

In the previous section it was already demonstrated that pointing is a superunit or agglomeration of different behavioural and possibly also cognitive components. Pointing is thus decomposable into many different subcomponents or subunits. This makes it likelier that pointing itself also functions as a level for at least some of its subcomponents, or, stated otherwise, that pointing is actually a location where certain subcomponents such as intentionality, or index-finger extension evolve. Table 2 outlines how we can study pointing as a level of language evolution.

4.1. Discussion of Table 2

4.1.1. The Question Mark Phase (1)

As it is uncertain whether pointing functions as a level where other types of behaviour can evolve, the level-heuristic recommends to try and prove that pointing is a level of language evolution and thus to go to the yes-phase of the heuristic.

4.1.2. The Yes Phase (2–8)

Identifying Pointing as a Level of Language Evolution (2)

How does one prove that pointing is a level of language evolution? One can prove that pointing is a level of language evolution if one can prove that language evolution units evolve at the level of pointing, or when evolutionary mechanisms can be identified that are active at the level of pointing. Either two research routes function as control mechanisms for each other, because the detection and investigation of units will also lend insight into the mechanisms

<p align="center">Table 2. Is pointing a level in/of language evolution? (read from left to right and top-down)</p>		
?	1. Try to prove that pointing is a level of evolution (1 example suffices). Thus go to yes .	
YES	2. How many/which units evolve at this level?	Not one unit, pointing is not a level of evolution, go to no .
		One/multiple unit(s)? Identify them all. (Justifies that pointing is a level.)
	3. How many evolutionary mechanisms are active at (not on) this level?	Equals the question: how many evolutionary mechanisms are active upon the units that evolve at this level. (testing device)
	4. What is the ontological status of the level?	The level is an abstract notion that facilitates theory formation/ an existing entity .
	5. Since when ?	Locate the origin of pointing in time or when it becomes necessary to invoke pointing as an abstract notion in the theory of language evolution
	6. How does this level pointing interact with other levels?	Can this level be divided into sublevels ? If so, are they also levels in language evolution?
		Can this level be absorbed into superlevels ? If so, are they also levels in language evolution?
	7. Can this level also be regarded as a unit and/or mechanism of evolution?	? & yes: try and treat the level as a unit and/or mechanism, go to unit and/or mechanism .
8. Relevance ?	Is the level pointing sufficient and/or necessary for evolution?	
NO	9. Unit and/or mechanism ?	? or Yes: go to unit and/or mechanism .
		No: treat pointing as irrelevant for evolution until proven otherwise.

that are active on the units (at that level); and the investigation of the mechanisms that are active at the level will lend an insight into the units that evolve at the level of pointing.

Possible units that manifest themselves at least partly through pointing are: the single word phase, two-word-phase, ToM, intentionality, problem-solving, emotionality, sociality, attention sharing, nonverbal communication, vocalisations, and verbal communication. That is, pointing can be a vehicle, a means to express all the above. And pointing can therefore be one of the levels or loci where evolutionary mechanisms become active on those units. ToM and intentionality partly shape pointing; vocalisations and verbal communication sometimes accompany pointing in ape and infant pointing; pointing requires an audience and thus a social environment; certain forms of pointing arise in relation to an emotional environment.

The fact that these units might evolve at the level of pointing does not necessarily make pointing a *level of language evolution* (it might simply make pointing a level in the evolution of problem-solving, for example). Thus, the heuristic recommends to test whether these elements are also units in language evolution (and thus whether they were part of the initial condition from wherefrom language evolved) or if they merely provide windows on the evolution of language. Only when the units that evolve at the pointing level are actual language units, is it proven that pointing is a level of language evolution.

Moreover, identifying language units that evolve at the level of pointing does not imply that these units exclusively evolve at the level of pointing. Rather, these units can be expressed at the pointing level and as such they can be prone to change, but they can also be expressed at other levels, such as the cognitive or the cultural level. In other words, pointing can serve as a *vehicle* where these units are expressed and as such, pointing is one level where these units can possibly evolve.

Which evolutionary mechanisms are active upon this level equals the question, how does ToM, intentionality, problem-solving, emotionality, sociality (e.g. attention sharing), nonverbal communication, vocalisations and verbal communication evolve? These questions require rigorous scientific investigation that is beyond the scope of the present article.

Examining Pointing as a Level of Language Evolution (4–8)

As soon as one or multiple language evolution units are identified to be subjected to a certain evolutionary mechanism at this pointing level, the heuristic again generates questions that allow one to systematize, constrain as well as evaluate the pointing level.

The Ontological Status of Pointing as a Level of Language Evolution (4)

Before being able to recursively ask the same questions in regard to the level as in regard to the unit, in the level-heuristic one additional question needs to be raised regarding the ontological status of the level.

Although pointing behaviour can quite simply be referred to in space in an ostensive manner as something that exists, levels such as “culture” or a “language community” cannot. It therefore becomes necessary to clarify whether the level under investigation is a real existing unit or a theoretical concept that is introduced to pragmatically facilitate theory formation.

“Pointing” is a theoretical concept that has been used to refer to a variety of phenomena that are either of a behavioural, cognitive or linguistic kind. Many of the sub-units of pointing exist in individuals (the index-finger, the thumb, arm, ...). Pointing can also be regarded as a level of evolution in that sense that it is a “vehicle” or a “level of expression” of certain types of behaviour. In this regard, an analogy can be drawn between genes and the phenotype. According to the Modern Synthesis, genes can only be the target of selection if they are phenotypically expressed and as such tested in a certain environment (a gene for blue eyes for example can only become the target of selection when it is phenotypically expressed). Likewise, ToM, intentionality, etc. can only evolve if there exists a medium where such behaviour is expressed. The level of pointing is one of those physical media.

In this regard, one can also ask if the vocalisations, the social context, the emotional context, etc. are part of the level of pointing. Do they need to be present in order for units such as ToM to be expressed and to evolve at this level?

When Did Pointing Become a Level in Language Evolution? (5)

This question on the ontological status of a level is especially relevant for the “since when” question. It is only useful to investigate when the level originated

in time when it is an actual existing entity. Otherwise, one has to specify when it becomes necessary to introduce pointing as a level in language evolution at a theoretical level.

The origin of pointing as a physical vehicle or level in time (for other units), depends to a large extent on the origin of pointing as a unit. The pointing behaviour has to exist before it can serve as a level for the evolution of other units.

How does the Pointing Level Interact with other Levels? (6)

The heuristic proposes a series of questions that again allow one to systematically search for other levels of language evolution, as well as units and mechanisms.

As an existing behaviour, the subunits (described above), might also be sublevels of language evolution. Possible superlevels are the level of motor-control, the level of non-verbal behaviour, or the level of culture.

How Relevant is Pointing as a Level for Language Evolution? (7)

The heuristic enables one to evaluate the importance of pointing in both the evolution of language as well as in the theories on the evolution of language.

As it is clear that other levels are implicated where language evolved, it can be concluded that pointing is neither sufficient nor necessary for language to have evolved, and theories on language evolution therefore cannot exclusively focus on pointing.

4.1.3. The No Phase (9)

A level of language evolution can only be identified as such if one can find units that evolve at that level by means of certain mechanisms. If one cannot identify either of these two, then pointing is not a level of language evolution.

4.2. Conclusion on Pointing as a Level of Language Evolution

This heuristic again demonstrates how a multitude of questions are generated by the systematic examination of pointing as a level of language evolution and, more importantly, how it also justifies a multitude of research routes.

Furthermore, on a meta-level, the heuristics enable insight into theory formation on language evolution, by explaining how relevant a certain research topic is to build theories.

5. Is Pointing a Mechanism of Language Evolution?

Before we can turn to table 3, some general notes on evolutionary mechanisms need to be made because by now, the reader will have wondered what exactly is denoted with the concept “evolution” or “evolutionary mechanism”. Why regard pointing as a “kind of evolution” rather than a “behavioural”, “developmental” or “cultural” trait? Or why, in table 1, understand operant conditioning (in the wake of Skinner, 1986 himself) as an “evolutionary mechanism” and not just as a “mechanism” or a simple “learning or teaching strategy”? Today, numerous theories and cultural intuitions withhold us from recognizing the latter as “kinds of evolution” or “evolutionary processes”.

I am reluctant to rigidly define “evolution” or “evolutionary mechanism” or to exclude the above as either one of the latter, for the following reasons. Historically, because evolution was first “discovered” in biology, the idea has always been that *only* life or biological organisms evolve, and that they exclusively evolve by means of natural selection. Evolutionary theory however has today progressed up to the point that it recognizes a myriad of different evolutionary mechanisms, such as drift, symbiogenesis, lateral gene transfer, etc. The consequence is that today, it becomes legitimate to investigate just how many evolutionary mechanisms exist and how they facilitate the evolution of various phenomena associated with life.

Darwin already made it very obvious that natural selection is a mechanism that requires the presence of certain measurable conditions, such as heredity, a struggle for existence etc. If we consistently think these ideas through, this also means that it is not the mechanism that, like some “force” or “law”, determines how evolution will occur, but that it are the material conditions that determine the (type of) mechanism.

It follows that mechanisms are not “out there”, waiting to be discovered. Rather, a series of measurable conditions under which something emerges or changes (i.e. evolves), are waiting to be identified as evolutionary mechanisms.

For evolution to occur by means of natural selection for example, according to Campbell (1974), elements needs to vary blindly, and some of these elements needs to be selected and retained through time. When such “blind

variation and selective retention” occurs, it is argued that something evolved by means of natural selection. Natural selection is therefore not a constant force but a series of measurable events that are denoted as “natural selection”. And these conditions can be summed up in heuristics (Campbell, 1974; Plotkin, 1995). The most important contribution of evolutionary epistemology has been the abstraction of several EE-formulas of evolutionary theories such as natural selection (Campbell, 1974; Plotkin, 1994 and see Gontier, 2007 for such a formula on symbiogenesis). These formulas point out the conditions that need to be met in order for evolution to occur by means of a specific mechanism.

In sum, mechanisms are processes that occur under well-defined and measurable conditions whereby change is induced. Conceived of in this way, an evolutionary mechanism need not always be as exotic as natural selection or symbiogenesis for example. Rather, as soon as one can identify a series of conditions by which something changes, one can call this series of conditions a mechanism whereby something evolves. It is very deliberating to regard evolution simply as change and evolutionary mechanisms simply as those conditions that need to be met in order for change to be inflicted upon something in a certain manner.

The potential of such a view is enormous and is also evident when we examine pointing as a possible mechanism in language evolution. Pointing is a behaviour that can inflict change in other types of behaviour. That is, pointing can change the way in which intentionality is expressed, in which the one- and two-word phase develop, etc. Because these behaviours are changed by pointing, it is interesting to ask whether we can also understand pointing as an evolutionary mechanism of language evolution (table 3).

5.1. Discussion of Table 3

Turning to the heuristic, it again recursively recommends that in an uncertain situation, one needs to try and prove that pointing is a mechanism involved in the evolution of language (1).

Similarly to the level phase, one can prove that pointing is a mechanism if one can identify units whereupon pointing is active (2), and if one can identify levels whereat pointing is active (3). Both serve as control mechanisms for one another, since the identification of units will lend insight into the levels where these units evolve and vice versa, the identification of levels will identify units.

<p>Table 3. Is pointing a mechanism involved in language evolution? (read from left to right and top-down)</p>		
?	<p>1. Try to prove that pointing is an evolutionary mechanism involved in evolution. Thus go to yes.</p>	
YES	<p>2. On how many units is this evolutionary mechanism working?</p>	<p>Not one unit: pointing is not a mechanism involved in language evolution.</p>
		<p>One/multiple unit(s). Identify them all. (Justifies that pointing is a mechanism involved in evolution.)</p>
	<p>3. At (not on) how many levels is this mechanism active?</p>	<p>Equals the question: the units that are subjected to this evolutionary mechanism, at how many levels are they subjected to it?</p>
	<p>4. How does the mechanism work? Which conditions need to be met in order for the evolutionary mechanism to occur? Answer requires (universal) EE formulas of the workings of the mechanism.</p>	
	<p>5. Since when?</p>	<p>Locate in time when these conditions are met regarding each unit and each level = when the evolutionary mechanism became a mechanism involved in language evolution at that unit and/or level.</p>
	<p>6. How does this pointing mechanism interact with other mechanisms?</p>	<p>Can this mechanism be divided into sub-mechanism(s)? (Depends on the presence of sub conditions.) If so, are they also mechanisms of language evolution?</p>
		<p>Can this mechanism be absorbed into a super-mechanism(s)? (Depends on the existence of a mechanism that allows to combine different mechanisms into one single mechanism.) If so, are they also mechanisms of evolution?</p>
	<p>7. Can this mechanism also be regarded as a unit and/or level of evolution?</p>	<p>? & yes: try and treat the mechanism as a unit and/or level, go to unit and/or level.</p>
<p>8. Relevance?</p>	<p>Is the mechanism pointing sufficient and/or necessary for evolution?</p>	
NO	<p>9. Unit and/or level?</p>	<p>? or Yes: go to unit and/or level.</p>
	<p>No: treat pointing as irrelevant for evolution until proven otherwise.</p>	

Possible language units that evolve by means of (the mechanism of) pointing are perhaps the one and two-word phase, referential communication, intentional communication and attention-sharing. This can be proven if we can attribute causation to pointing, and falsified if we cannot. For example, pointing could be a mechanism for the one or two word phase if we can demonstrate that pointing causes, triggers or induces the production of single words under certain, recurring circumstances. This in turn would imply that there would exist a cognitive or neurological relation between the production of pointing and the production of single words. Whether this is the case needs to be examined.

Specific to the mechanism heuristic is the question: how does the mechanism work (4)? Which conditions need to be met in order for evolution to occur through pointing? At this stage, the heuristic again starts to generate questions that allow one to systematically study the mechanism. And it is here that AEE and philosophy of biology can again contribute in a major way, i.e. by examining which universal conditions need to be met in order for a certain evolutionary mechanism to occur.

In regard to natural selection, evolutionary epistemologists such as Campbell and David Hull for example, have identified the conditions under which natural selection occurs in the form of EE-formulas or heuristics. Campbell “universalized” natural selection theory and freed it from genetic research. Not only genes, but all entities that evolve according to the blind variation and selective retention formula can be argued to evolve by means of natural selection.

As such, it would be an interesting intellectual exercise to identify the conditions that need to be met in order for pointing to occur. Leavens has already been engaged in this activity. Pointing as an act of nonverbal reference occurs when the following 4 conditions are met: there must be social interplay, visual orienting behaviour, putative attention-getting behaviour, and persistence (Leavens, 2004; Leavens, Russell & Hopkins, 2005). According to Leavens, pointing can only be argued to occur under these circumstances. One could also investigate whether these conditions necessarily need to be in place before change can be induced in nonverbal communication by pointing. It is a challenge for scientists to investigate what kind of (ir)reversible behavioural responses pointing can induce, alter or change when these conditions are met and whether one could argue that these changes are of an evolutionary nature.

Afterwards, the heuristic again recursively introduces questions that allow one to systematize, constrain and evaluate the importance of pointing as a mechanism (5–8). Most of these questions cannot be answered yet and also the idea that pointing can be regarded as a mechanism of language evolution, in line with natural selection, is a highly tentative suggestion.

Nonetheless, this example again shows how the heuristic is obliging us to re-conceptualize certain aspects of evolutionary research.

6. Conclusion

It has been demonstrated how pointing can be implemented and investigated from within the three evolutionary epistemological heuristics. Guidelines were given to how we can investigate whether pointing can be characterized as a unit, level or mechanism of language evolution. All three applications have *generated* as well as *constrained* research avenues on pointing. Furthermore, the study of pointing not only implicates, but also *justifies* the investigation of a multitude of additional (possible) units, levels and mechanisms of language evolution. Finally, it is also demonstrated how the relevance of pointing for the evolutionary origin of language can be *evaluated*.

It remains bizarre to understand units (simultaneously) as possible levels and mechanisms or vice versa, levels as possible units and mechanisms or even mechanisms as possible units and levels. Nonetheless, the rather simple behaviour that pointing is, allows us to assume that the former might at least hold some truth. But even if pointing is, at best, merely a unit of language evolution, the above example aptly demonstrates that the implementation of the AEE-heuristic into evolutionary linguistics generates new research questions and new avenues of research. Moreover, it allows to ground every step along the way.

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