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GRAMMATICALIZATION PATHS AND CHAOS: DETERMINISM AND UNPREDICTABILITY OF THE SEMANTIC DEVELOPMENT OF VERBAL CONSTRUCTIONS (PART 2 – CHAOS IN LINGUISTICS)

Abstract

This paper demonstrates that by applying Chaos Theory to the modelling of the evolution of verbal forms and verbal systems, it is possible to view classical grammaticalization paths as universal, and align this deterministic assumption with the unpredictability of concrete grammatical developments. The author argues that such an explanation is possible because traditional grammaticalization paths do not represent realistic cases of grammatical evolutions, but rather correspond to abstract and non-realistic deterministic laws which codify the order of the incorporation of new meanings to the semantic potential of a gram. Therefore, from a synchronic perspective, they can be used to represent the semantic potential of a form as a map or a state. In contrast, a realistic development emerges as a trajectory connecting such maps or states. Consequently, the cross-linguistic typological model of realistic evolutionary processes of a certain type corresponds to a state-space – it is a cluster of all possible trajectories the grams of a certain class can travel. This article – the second of series of three papers – will deal with a principled application of Chaos Theory to linguistics and with a new alternative interpretation of paths postulated by Path Theory.

1. Where we left off

The previous paper – the first in the series – discussed the phenomenon of chaos in mathematics. In non-formal language, mathematical chaos is the unpredictable

behaviour of non-linear dynamic systems that, albeit governed by deterministic dynamic equations, are highly sensitive to initial conditions. If the treatment of chaos is more formal, it surfaces in three standard definitions proposed by Devaney, Strogatz, and Smith. According to the first definition, a dynamic chaotic system is sensitive to initial conditions, topologically transitive (being characterized by mixing), and its periodic orbits are dense (Devaney 1989). According to the second definition, "[c]haos is aperiodic long-term behaviour in a deterministic system that exhibits sensitive dependence on initial conditions" (Strogatz 1994: 323). According to the third definition, chaotic systems are characterized by stretching and folding behaviour (cf. the horseshoe phenomenon), are exponentially sensitive to initial conditions, which can be measured with the Lyapunov exponent, and these systems' maps have positive topological entropy (Smith 1998). Lastly, a number of specific properties exhibited by chaotic systems have been presented, such as attractors, strange attractors, fractal structure, bifurcations, basins, and emergence.

Having explained the mathematical theory of chaos, another question arises: how can we transfer this mathematical model to other fields of science, such as linguistics. Chaos Theory is an abstract mathematical model. It cannot be freely transposed to the study of languages, because chaos in mathematics and chaos in linguistics do not imply exactly the same thing. Only a principled application of Chaos Theory (in which reductions and simplifications imposed by modelling would be acknowledged and controlled) can warrant an adequate use of a chaos narrative in linguistics – a use that would go beyond imprecise metaphors and vague comparisons. Such a precise definition of chaos that would specifically be designed for and applicable to linguistic science must be formulated.

The present article will deal with the use of Chaos Theory in linguistics. I will first address the issue of modelling – the basis of a principled manner of applying Chaos Theory to linguistics (Section 2.1). Afterwards, I will propose a definition of chaos that can be applied to the study of languages, more specifically to the theory of grammaticalization paths (Section 2.2). This will subsequently enable me to analyze Path Theory from a new and, arguably, more appropriate perspective. From this perspective, traditional paths are not models of realistic evolutions (Section 3.1). They are rather matrices that schematize sequences and possible ranges of senses incorporated into the semantic potential of grams of certain types (Section 3.2) – matrices that can be used to model synchronic semantic potentials of grams (i.e. the meanings of grammatical forms offered at a determined point in time; Section 3.3).

2. How can Chaos Theory be useful in linguistics – "non-mathematical" chaos

2.1 Modelling problem

From the discussion in the previous paper of the series, we have learned that Chaos Theory is a mathematical model of some dynamic systems. And this fact is crucial: it is a mathematical theoretical representation. Mathematical models typically

misrepresent realistic facts (Smith 1998: 42, 50). This is already observable in physics, where empirical data does not always entirely adjust to the requirements of the theory. Accordingly, chaotic models also idealize the real state of affairs. This idealization appears because natural phenomena (to the description of which the mathematical model has been applied) lack the fractal intricacy or period doubling that are characteristic of mathematical chaotic organizations (Smith 1998: 51, 98–105).

Similar to all mathematical macro-physical theories, the mathematical chaotic representation is idealized. That is, it provides an approximately true account and explanation of phenomena belonging to the realistic physical world (Smith 1998: 71–72; Diéguez Lucena 2010: 66). During the modelling of a concrete physical organization in accordance with Chaos Theory, the system being analyzed is portrayed as a geometric configuration where numerical values correspond to a given physical behaviour. In this manner, one constructs abstract theoretical trajectories that symbolize time evolutions of dynamic systems in the real world (Smith 1998: 72). The encoding of states achieved by a system is especially arbitrary and sometimes – for instance, in social sciences or in fields where the objective measurability strongly decreases – even metaphorical (Auyang 1998b: 213).

Moreover, although the modelling appears as strictly numerical and geometrical, one should be aware that physical quantities corresponding to realistic properties are coarse-grained. Consequently, hypothesized trajectories should be understood as fuzzy. Nevertheless, in the model, we consistently treat them as regular and discrete, assuming this representation to be a pure idealization (Smith 1998: 73). To put it differently, since in the real world we are faced with fuzzy-valued quantities while applied mathematical models work with precisely determined real numbers, in the modelling process, scholars must inevitably fictionalize. This means that mathematical dynamic models of chaos have surplus content, "pretending that there is precision in the values of relevant physical quantities where there is not" (Smith 1998: 127). What excuses such an idealizing procedure and gives a reason for it?

Scientists fictionalize and represent real-world coarse-grained quantities in precise fine-grained numbers because there is no other alternative. The hypothesized precise quantities in a chaotic model applied to real systems are fictions. Nevertheless, as Smith (1998: 127) convincingly argues, *this does not matter*. Since the idea of fuzzy mathematics remains still quite unconvincing, there is no other option (compare however Zadeh 1973; Dimitrov 2002: 15; Dimitrov, Hodge 2002: 31; Dimitrov 2005). Albeit the model is fictional to a degree, we can still extract a broad range of features from it, by merely knowing that it is approximately true and tolerably realistic. Scholars just have to **defictionalize** the model's results. This means that after reaching unrealistically precise predictions or explanations of certain quantities –as these were built on numerically precise initial conditions and parameters – one must again fuzzify such predictions and descriptions (Smith 1998: 127–128). In other words, one conserves the unrealistic cleanness and precision of the model, being conscious of the fact that the fuzziness must be taken into account when the model is applied to real world quantities and organizations. This is a procedure with which a scientist can extrapolate pertinent information

from models that offer an excessive content due to the over-idealized precision of values that is fuzzy in the realistic universe.

Furthermore, theoretical models drastically simplify the real picture. Being built on approximations, they necessarily leave out a good number of details. They portray a given physical organization in ideal terms, focusing only on some relevant macro-variables and crucial relations (Auyang 1998b: 69; Diéguez Lucena 2010: 75). Approximations and idealization, however, are not simple defects. On the contrary, they play a crucial role in science (Diéguez Lucena 2010: 66). Mathematical models and their solutions are exact in the formal and logical sense, but not in the sense that they impeccably reflect reality. Real-world systems are not sufficiently simple in order to behave in a perfect accordance with universal laws (Diéguez Lucena 2010: 75). A mathematical (as well as empirical) theory is not required to be complete, exhausting all real-world factors. It is expected to incorporate the most relevant ones, formulating them in the manner that would provide nearly accurate solutions (Auyang 1998b: 67–68). Hence, abstract models – either empirically testable or not – are beneficial and useful for they enable scholars to encapsulate some essential properties and behaviours of realistic systems, by providing approximate explanations and predictions. They offer a coherent vision of a few salient factors of a system. Knowing such theoretical characteristics of the idealized system, we gain in the understanding of similar organizations and processes and/or in more realistic conditions (Auyang 1998b: 70).

Therefore, it is possible to extract certain pieces of information which are relevant for the real world from properties provided by purely mathematical material (i.e. encoded by numerical, unrealistic and fictionalizing models) – even the most simplified. This is particularly feasible if such properties constantly appear in a large set of models constituting robust traits (Smith 1998: 126). When applying a model to realistic phenomena, one merely disregards the surplus content provided by the theory and considers this surplus as purely fictional. That is, a scientist focuses exclusively on relevant features, i.e. on properties which appear as robust. In this manner, such robust truths may be understood as super-truths, namely as statements which remain true in models with any permissible initial state (Smith 1998: 129).

If one keeps in mind the above-explained relationship between theoretical models and the realistic universe, the mathematical model of chaos may be useful for the representation of natural phenomena. That is, certain robust properties of mathematical chaos may be successfully identified in idealized models of physical systems. If there is a correlation between this idealized representation of a realistic system and the mathematical model of chaos, a given real-world process can be identified as chaotic. In this manner, what superficially appears as noisy, disordered, intricate, and (in everyday sense) chaotic may be represented as an abstract model of chaos. In other words, the evolution of real world variables that appears as more or less erratic, when pictured into the state-space idealization, sometimes generates mathematically prototypical chaotic structures if conducted in a perfectly precise manner.

The correspondence between a hypothesized model of realistic phenomena and the model posited by Chaos Theory (and thus the explanation of real-world systems in terms of mathematical chaos) is both possible and recoverable because of idealizations employed (Smith 1998: 127–128, 142). However, when equalling natural systems with a mathematical chaotic system, it is necessary to constantly filter out the mathematical substance (precise and ideal) from the non-mathematical substance (fuzzy and realistic). One must always be aware of the surplus content which is characteristic of any theoretical representation (Smith 1998: 127). One should, therefore, trust the robust features, focusing on the properties that are the most stable both in the mathematical model and in a given real-world organization.

2.2 Linguistic definition of chaos

Having explained the mathematical theory of chaos and the modelling problems related to its application to real-world phenomena, I will propose a definition of chaos relevant to linguistics, and in particular to the study of semantic developments of verbal grams.[1]

Overall, the application of chaos to other fields of studies can be numerical, narrative or mixed (i.e. encompassing numerical and narrative character). In this paper the transposition of Chaos Theory to linguistics is mainly used as narrative, sometimes intermingled with more precise features, especially topological ones (e.g. waves). In this manner, I continue the method adopted by Bybee (2010), who was, to my knowledge, the first scholar to suggest the compatibility of semantic paths with the narrative of Chaos Theory. Since my model is principally built around such a narrative, it will not contain and/or yield exact mathematic calculations and/or numerical representations. This, however, should not be viewed as weakness (compare the same approach in Bybee 2010; see also Larsen-Freeman 1997; Massip-Bonet 2013; Munné 2013). The use of models imported from hard sciences (especially, mathematics and physics) in the form of narratives is common in social sciences and offers numerous advantages (cf. Auyang 1998a). As explained previously, such non-numerical narratives may be employed under the condition that a given narrative is not a mere analogy but is used as an exact heuristic method. Specifically, each term in the target model should be demonstrated to be equivalent to the original terms from the numerical model.

Chaos Theory (in its narrative and/or more mathematical versions) has been applied to linguistics or discussed for linguistic purposes by several scholars. Among the more narrative applications and discussions, the most relevant are those developed by Schneider (1997, 2013) for dialect variation, by Larsen-Freeman (1997) for applied linguistics (see also Cooper 1999), by Bybee (2010) for grammaticalization theory, by Massip-Bonet (2013) for language change (especially from a sociolinguistic

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[1]   This implies that I will not be concerned with the application of Chaos Theory to other linguistic and grammatical phenomena. As will be evident from the subsequent discussion in this section, Chaos Theory (both in a narrative and a numerical form) has extensively been used in various branches of linguistics.

perspective), by Munné (2013) for linguistic categorization, and, lastly and more comprehensively by Kretzschmar (2015).[2] A more computational implementation of Chaos Theory in the field of linguistics, including cognitive linguistics (especially in morphology, semantics and syntax) has been developed by Wildgen (1998, 2005) and Wildgen and Plath (2005). One should also mention an extensive application of the catastrophe theory to linguistics by Wildgen (1982, 1983, 2004, 2005). Even though the catastrophe theory is not synonymous with Chaos Theory, it can be regarded as its predecessor because it was concerned with bifurcation in non-linear systems. Other related frameworks or approaches correspond to a dynamic neural network model (or a family of such models) and complex-systems theory which also analyze the behaviour of language as a complex dynamic system (cf. Massip-Bonet, Bastardas-Boada 2013). Among all these approaches and scholars, only Bybee (2010) focuses on grammaticalization semantic paths, making an important observation concerning the attractors of paths.[3]

A given linguistic organization will be understood as chaotic if, after idealization and fictionalization – i.e. being treated as if physical values were exact and corresponded to mathematical quantities either in a precise mathematic representation or in a more metaphorical narrative – the resulting model *approximates* the mathematical theoretical representation established by Chaos Theory. In other words, once the grammatical developments receive a geometrical, idealized and fictionalized, representation (either precisely numerical or more narrative), the *robust* features of the evolution of grammatical systems would fulfill determined, expectedly *robust*, properties of prototypical chaotic organizations.

This definition implies two things. First, one is required to represent a complex state of affairs in the real world as an idealized point in the phase space of a geometrical model and to treat the development of multifaceted, coarse-grained and, in some aspects, difficultly measurable or unquantifiable values pertinent to a linguistic organization as concrete mathematical objects and quantities (points, sets of points, surfaces, vectors or waves). Second, the correspondence between a geometrical idealization and fictionalization of the physical system, on the one hand, and the mathematical system posited by Chaos Theory, on the other, is not required to be *absolute* and *perfect*. It is sufficient if the two models coincide in certain robust features.

All of this means that a given linguistic process or a grammatical structure will be considered chaotic if its modelled representation delivers a dynamic, non-linear, a-periodic system which, although governed by deterministic laws, is unpredictable (as far as long-term estimations for a concrete trajectory), due to a high sensitivity to initial conditions, displaying a stretching-and-folding behaviour on attractors. In light of this last point, the model suggests the existence of (strange)

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[2]   Kretzschmar (2015: 15–19, 31, 125) expresses certain doubts concerning the chaotic nature of language and the usefulness of Chaos Theory for language analysis.

[3]   As correctly noted by Bybee (2010: 198), such attractors are strange in the sense of Chaos Theory (regarding the concept of strange attractor, see Sections 2.3 in the first paper of the series and Section 3 in the third paper).

attractors, basis and bifurcations – properties typical of chaotic organizations. The fulfillment of all the above-mentioned characteristics will enable us to view a given grammatical process or system as chaotic. However, the matching may be less impeccable and the entire correspondence between the model of a realistic system and the mathematical theory can be limited to a certain number of the most characteristic features. Thus, as far as linguistic objects are concerned, the idea of being chaotic should be understood as a *continuum* of degrees of equivalence between a modelled linguistic structure and an archetypical chaotic system, ranging from states of lesser equivalence (non-prototypicality) to states of greater equivalence (prototypicality).

3. Alternative understanding of Path Theory

Before developing a chaotic model of the semantic evolution of grammatical constructions (see the next paper in the series), I will discuss the status of paths as proposed by Path Theory. The validity of these paths remain unchallenged, if they are understood not as models of realistic developmental cases but rather as models of the incorporation of new senses into the semantic potential of a gram. Given this, they can be employed to depict synchronic states of grammatical forms. As a result, paths may be upgraded from inductive generalizations to scientific laws and be viewed as universal and deterministic. This new understanding of paths will be crucial for the formulation of a chaotic model of realistic evolutions of grams.

3.1 Paths as models of developing grams

The standard path model is usually comprehended as representing realistic evolutions. Following this idea, stages on a given cline are assumed to represent different grammatical categories. Put differently, according to Path Theory in its classical version, grammatical constructions seem to "mutate" from a certain gram g_1 into another gram g_2. The sequence of such stages constitutes a path that seemingly represents a typologically common evolution. I will illustrate this by using an anterior path.[4] The anterior path provides a model of the grammatical development of original resultative or completive grams (e.g. Nedjalkov, Jaxontov 1988: 3–63; Bybee, Perkins, Pagliuca 1994: 51–105; Dahl 2000a: 14–17; Nedjalkov 2001: 928–940). In its standard shape, this cline states that resultative proper grams evolve into present perfects which subsequently transmute into perfective or simple past tenses:

RESULTATIVE PROPER ⟶ PRESENT PERFECT ⟶ PERFECTIVE PAST / SIMPLE PAST

Figure 1: Anterior path (adapted from Bybee, Perkins, Pagliuca 1994 and Dahl 2000a)

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4   Other labels used for this cline are 'aoristic', 'past' or 'towards perfective and past' (cf. Bybee, Perkins, Pagliuca 1994; Dahl 2000b; Squartini, Bertinetto 2000).

This understanding of paths has certain limitations. On the one hand, it is usually considered to be *quasi* universal – it schematizes a common tendency rather than a deterministic law. On the other hand, and even more importantly, it fails to encapsulate the various evolutionary scenarios affecting original resultative constructions.

First, one may encounter multiple examples where formations that are defined as past tenses offer uses which have nothing to do with the semantic domain of a definite past. That is, they may convey the ideas of a future tense, a counterfactual mood and a deontic mood. For example, in numerous languages, grams that are employed in the function of a definite past are able to express future events. This phenomenon is particularly frequent in subordinated temporal clauses (e.g. in Mandinka *Niŋ a naata, ntel be dokuwo ke la* 'When he comes (lit. came), we will work') although it may also be found in main clauses (see *Je l'ai fait dans 5 minutes* 'I will have done (lit. did or have done) it in 5 minutes' in French). Modal uses (especially, counterfactual and deontic) of the constructions which, in their prototypical sense, act as perfects or past tenses are equally common. The former value can be illustrated by the use of the so-called "suffix conjunction" *qatal(a)* in the Semitic family (cf. Andrason 2013a), whilst the latter may be exemplified by the Polish perfective past (*Wczoraj napisał list* 'Yesterday, I wrote a letter') which in certain cases provides modal deontic, real-factual nuances (*Napisał (już) mi ten list!* 'Write this letter (now)!').[5]

Second, rather than functioning as a category that matches only one stage of the anterior path (for instance, a resultative proper, a present perfect, a perfective past or a simple past in the model proposed in Figure 1), grammatical constructions that evolve along the anterior path tend to be employed as amalgams of many stages located on this cline. That is, realistic grams display senses that correspond to more than one phase of the anterior trajectory. For example, *passé composé* in French may be employed in the function of a resultative proper, a present perfect, a perfective past and a simple (i.e. aspectually neutral) past (Grevisse 1975). Consequently, it can span the entire anterior path (Andrason 2010a: 340–341). In a similar vein, depending on a given context, the Akkadian (Semitic) *iprus* formation behaves as if it were a stative, a present perfect, a perfective past or a simple past (Andrason 2010a: 336–340). This behaviour is obviously not restricted to grams travelling along the anterior path, but rather concerns constructions of any diachronic and synchronic type. It stems from the fact that grammatical forms are inherently polysemous – polysemy being the norm in languages (Lewandowska-Tomaszczyk 2007).

Probably, one of the most evident examples illustrating the two above-mentioned phenomena is the Biblical Hebrew *qatal* form, which besides functioning as a resultative proper, a present perfect, a perfective past and a simple past (gram types that jointly cover the entire anterior cline), additionally acts in certain instances as a counterfactual mood, an imperative, an evidential and a future (Andrason 2011a, 2013a). No path can account for such a polysemy within the frame of the standard model. Bybee, Perkins and Pagliuca (1994) are fully aware of this phenomenon.

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[5] A similar situation can be observed in Semitic or Niger-Congo linguistic families (Andrason 2013a, 2013c, 2016).

They correctly notice that grams *retain* the senses previously acquired for a long time, and probably, for this reason split the present perfect stage into "young" and "old" anteriors. The former gram stands for prototypical present perfects while the latter represents constructions that offer additional uses which correspond to definite past functions – it is a past tense that has preserved its original perfect senses.

Another excellent example of the incompatibility of the standard path model with realistic evolutions is provided by so-called modal paths (Bybee, Perkins, Pagliuca 1994: 240). One of such trajectories – the ability path – shows how expressions of mental or physical ability develop into grams that convey the meaning of root possibility, and subsequently the meaning of epistemic possibility and potentiality. After that, they may evolve into expressions of permission and/or prohibition. Additionally, a gram that is employed with the sense of root possibility commonly develops into an intentional and desiderative construction, which, in turn, can evolve into a modally coloured future. It is clear that such a path does not portray a realistic evolution of a gram in the sense that each stage on the cline would correspond to a subsequent developmental phase of this formation, i.e. at the time *a*, *b*, *c*, etc. Grams that arise from ability inputs and evolve along the ability cline typically offer senses that reflect various stages located in this path. They accumulate values predicated by the path so that their semantic potential may correspond to a large section of the cline (for instructive examples, consult Bybee, Perkins, Pagliuca 1994; Andrason 2010b).

3.2 Paths as models of incorporation of senses

The imperfections explained in the previous section can be overcome if paths are understood as templates of an ordered incorporation of senses into the semantic potential of verbal constructions, and not as models of realistic evolutions that show how grams evolve from one stage to another. In this manner, instead of symbolizing realistic grams, each stage refers to a semantic value that can be incorporated into the total meaning of a gram. In other words, stages correspond to consecutive meaning extensions that arise from language use. As a result, the progression on the cline (i.e. the accessibility to a given sense, including a value which is situated at the very end of the trajectory) does not necessitate that the senses acquired earlier (i.e. values that correspond to more initial stages) be lost. Quite the reverse is true; original senses may survive for a long time even though the gram has advanced on the path and is now able to convey values that reflect ultimate portions of the cline. The model informs us only on the order of incorporated senses but not on their extent of accumulation. Returning to the anterior path, this new interpretation implies that grams do not mutate from a resultative proper into a perfect and, next, into a past tense. Original resultatives rather acquire additional present perfect senses. Subsequently, they may gain an explicit past value, first perfective and subsequently non-perfective. Consequently, formations that are born as resultative proper may span any section of the cline from the resultative proper to the simple past (Andrason 2011a, 2012a, 2013a, 2013b).

Since the model is interpreted as specifying the order of incorporation of new senses into the semantic potential of certain types of formations and not as a collection of historical phases of realistic grammatical constructions, other senses emerging from subsequent "stages-values" on the standard cline can easily be acknowledged and added to the representation. In this manner, various non-canonical values can be related to the most common ones, thereby yielding a map of possible meaning extensions available for a determined taxonomical class. For instance, the values of modal counterfactuality, futurity, probability, necessity (order), etc. can all be connected to the anterior path by means of branches that symbolize, less common – but yet possible – meaning extensions departing from the standard senses located on the anterior path (resultative, perfect, perfective, past; for illustrations of this consult Andrason 2011a, 2011b, 2012b, 2013a).

It should also be noted that this understanding of the path model enables scholars to fragmentize the clines into a highly fine-grained representation with a large number of specific "stages-values". Thus, it is possible to provide a more precise model of evolutionary meaning extensions in which twenty or more stages can be identified instead of the three or four stages posited previously. In fact, there is no limitation to the increase of granularity because the cline may always be made more precise (or more fine-grained), thus including steadily more microscopic senses. For example, one can design the following more detailed model of the anterior cline. At the beginning, resultative constructions acquire dynamic present perfect senses in the following order: first the gram develops an inclusive value,[6] then resultative,[7] experiential[8] and finally indefinite.[9] After that, the formation is admissible in explicitly past environments, developing definite past senses that correspond to an increase in the temporal distance from the enunciator's here-and-now. The gram progressively expresses actions or activities that are located in a more distant past moment: first in an immediate past (e.g. hodiernal, hesternal, or recent) and then in a more distant past (general and remote). Additionally, during the incorporation of a definite past sense, perfective values seem to be acquired before non-perfective ones (e.g. durative senses). In this manner, an upcoming past gram first provides an aspectual perfective sense and only later does it become acceptable in durative

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[6] The inclusive anterior (also labeled as universal) indicates that an action or state holds without interruption from a determined point in the past to the present moment, e.g. *I have known Max since 1960* (Jónsson 1992: 129–145).

[7] The resultative anterior introduces dynamic events, portraying them as highly relevant for the present state of affairs, e.g. I cannot come to your party – I have caught the flu (McCawley 1971).

[8] The experiential anterior indicates that the subject has an experience of having performed (or not) a given action. This means that the activity is portrayed as an experience which occurred at least once, and which might have been repeatable, e.g. I have never read that book or I have read 'Principia Mathematica' five times (Jónsson 1992: 129–145).

[9] The indefinite perfect (also labeled indefinite past) indicates events that are clearly past without, however, specifying their temporal location. As for the former property, the gram approximates a past tense. However, given the latter characteristic, the formation behaves as a typical present perfect. Therefore, in Figure 2 below, it is located between the semantic domains of a present perfect and past tense.

or non-perfective milieus (Harris 1982; Bybee, Perkins, Pagliuca 1994; Squartini, Bertinetto 2000; Lindstedt 2000; Heine, Kuteva 2006, 2007; Andrason 2011b, 2012b, 2013a, 2013b).[10] The entire scenario can be schematized as follows:

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  RESULTATIVE PROPER
  INCLUSIVE PERFECT
  RESULTATIVE PERFECT
  EXPERIENTIAL PERFECT
  INDEFINITE PERFECT
  HODIERNAL PAST                    PERFECTIVE PAST[11]
  HESTERNAL PAST
  RECENT PAST
  GENERAL PAST
  REMOTE PAST                       NON-PERFECTIVE PAST
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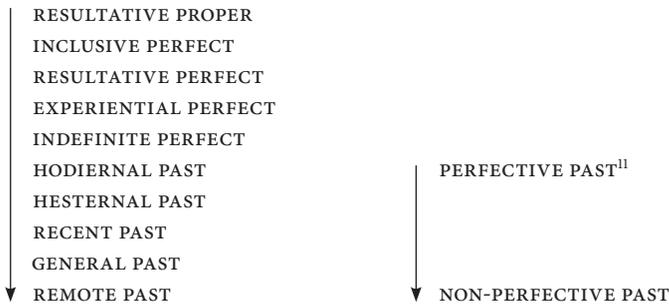
Figure 2: Anterior path as a sequence of incorporation of new senses[12]

Once the path is understood as a model of incorporation of senses (where the stages of a cline represent not the grams but rather the values or semantic domains), its status can be upgraded to a universal and deterministic law. This means that the above-posited representation of the anterior path offers an abstract model of the development of resultative constructions in the way that it *predicts* the uniquely possible order of the acquisition of new senses corresponding to semantic domains. It is a deterministic rule specifying an ordered universal sequence of incorporated values from the initial sense x_0 to the final sense x_Z through a set of intermediate senses $x_1 \ldots x_n$.

It is at this theoretical level where the trajectory becomes universal and deterministic (Dahl 2000a: 12; Traugott 2001: 1, 5). Just like in natural sciences, it is possible that in the context of a concrete observation the rule does not operate. However, it is so not because the law has ceased to be valid, but because other parts of the environment and, especially, other rules have interfered. Accordingly, paths – viewed as representations of meaning extension – correspond to abstract idealizations or theoretical laws where all realistic disturbing factors or "noises" are disregarded.

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[10] The grouping of such perfective and non-perfective values delivers the category of a simple past tense (cf. Bertinetto, Lenci 2010: 36–38).

[11] As a definite past, the gram may undergo two independent developments, to some extent. In the process, the gram increases its temporal distance from the speaker's here-and-now, being admissible in more remote contexts: immediate > hodiernal > hesternal > recent > general (a person's life past) and remote (historical and ancient) past. In the other process, certain aspectual nuances are acquired, first perfective ones (perfective past) and next durative or non-perfective ones (the gram functions as a simple past – an aspectually neutral gram). This aspectual development is restricted to certain types of verbal systems (cf. Bybee, Perkins, Pagliuca 1994). There is no precise stage-to-stage equivalence between the stages which link the indefinite perfect and various subcategories of the definite past on the one hand, and the development of the perfective past into its aspectually neutral variant, on the other.

[12] The vertical arrows in this figure symbolize a diachronic progression of resultative inputs.

They operate in an ideal world where they are totally deterministic and not only statistically common. Although based upon limited empirical evidence, their strength is universal. This universality, however, is valid only at the abstract level, where all the processes have been simplified and represented in isolation from the other sections of the system. A law that represents a phenomenon is regarded as being independent from the rest of the system: no relations with other elements are envisaged.[13]

This abstract universality of paths and their determinism do not signify that all grams in all languages invariably evolve in the same way. It rather implies that language development is governed by certain universal, theoretical and, thus, abstract rules. These rules, which provide an idealized and fictionalized picture of the phenomenon, can be comprehended as universal truths and deterministic principles (on this phenomenon in science, consult Luisi 2010: 26). Consequently, by induction, we take our generalization for laws, being aware that they are "hypothetical universals". In doing so, the path model does not differ from any empirical theory and its statements are as universal as biological, chemical or physical laws. Like biology, chemistry and physics, this new version of Path Theory interprets a limited amount of cases as representative enough and, by induction, predicts that under such and such conditions all entities of a given type should behave in such and such a manner.

3.3 Paths as models of synchronic semantic potentials

The above-mentioned understanding of clines does not diminish or compromise the relevance of the already detected paths. On the contrary, trajectories receive a stronger theoretical position by being understood as deterministic rules with no statistical dependency.

First, as has already been mentioned, they correctly codify the sequence and direction of accumulation of meanings during the evolution of the grams by predicting subsequent senses to be acquired. They inform us how constructions traverse the semantic space of the verbal system from taxis to tenses, through aspects. By doing so, they constitute deterministic laws or principia which control realistic grammatical developments despite the fact that they, themselves, do not encapsulate such realistic evolutionary processes. Second, they serve as matrixes for the explanation of states (or semantic potentials) that are available synchronically.

The latter phenomenon is referred to as (cognitive or dynamic) mapping (cf. Haspelmath 2003; Andrason 2016) or panchrony (Heine, Claudi, Hünnemeyer 1991; Andrason 2010b, 2013). This procedure interprets synchronic states as

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[13]   It is by using this scientific idealization and – to an extent – falsification, science formulates its postulations, principles, laws and theories. This is, in fact, the only way that science can proceed with developing its representations of the universe. As previously mentioned, in all models, scientists idealize the real world because they cannot represent the universe as it is (Auyung 1998b). Scientists typically formulate the laws offering a model of how a given process, fact or phenomenon will be if it is taken separately in isolation and in ideal conditions. They ignore frictions, accidental forces, adjacent noises and disturbing relations. This means that in science the universality and determinism refer not to the universe itself but to scientific interpretations.

being diachronic processes (both universal and concrete) and defines the synchronic semantic content of a construction as a portion (a set of stages x_0, x_1 … x_n, x_Z) of a given path-law. This interpretation of paths harmonizes with the principle of cognitive linguistics according to which the synchronic semantic variation of a form reflects that form's own history. As such semantic variations are viewed as static vestiges of consecutive diachronic changes, the overall meaning of a form is represented as a map (cline or network) whose components are organized diachronically. The usefulness of semantic maps based on diachronic universals has been widely acknowledged and such maps have commonly been employed (for a detailed discussion of the panchronic methodology and dynamic view of grammatical categories, as well as for a discussion of the usefulness of dynamic semantic maps, see Heine, Claudi, Hünnemeyer 1991; Bybee, Perkins, Pagliuca 1994: 204; Haspelmath 2003: 211–242; De Haan 2010, 2011; Lewandowska-Tomaszczyk 2007; Bybee 2010; van der Auwera, Gast 2011: 166–189; Narrog, van der Auwera 2011: 318–327; Andrason 2010b, 2011a, 2011b, 2012a, 2012b, 2013a, 2013b).

In the case of the anterior path, given that the model determines the order of the senses that are incorporated into the total meaning of an originally resultative construction, the unidirectional chain (either coarse-grained as in Figure 1 or fine-grained as in Figure 2) has frequently been employed in order to map the synchronic semantic potential of concrete and realistic grams that have developed from resultative inputs. Put differently, given that resultative proper formations incorporate taxis, aspectual and temporal values by following the sequence established by the anterior cline, the overall meaning of a post-resultative formation – its entire polysemy – is typically equalled with a portion of the trajectory. In such maps, each specific sense matches a stage on the path that symbolizes the historical moment where that value has been acquired. This means that post-resultative grams may be understood at any moment of their evolution as amalgamations of senses that correspond to the stages of the anterior path and any of its possible extensions arisen by means of less canonical branches. Accordingly, the total meaning of a gram – its *state* at a time *t* – is portrayed as a map whose components are organized along universal and deterministic paths. Inversely, the meaning of a formation is not elevated (and/or reduced) to one diachronic phase (a single stage of a path) but, by acknowledging a typical variation of uses and functions (i.e. the polysemy of this firm), is represented as various phases of the cline. In an extreme case, a gram can convey meanings which cover (almost) the entire trajectory.

Such an extreme case (which is in fact not rare crosslinguistically) is offered by Biblical Hebrew. In Biblical Hebrew, the form referred to as *qatal* is compatible with all the senses of the anterior path: resultative proper, perfect (all its subtypes), definite past (of any degree of remoteness), perfective past and non-perfective past. Accordingly, the map of the *qatal* gram spans the entire length of an anterior path, i.e. from its initial phases (resultative proper and resultative perfect) to highly advanced stages (remote and narrative (non-perfective) past; cf. Andrason 2013a, 2015). The mapping may be more coarse-grained (as in Figure 3a) or more fine-grained (as in Figure 3b). The former corresponds to the granularity level offered by the anterior

path designed by Bybee, Perkins, Pagliuca (1994) and Dahl (2000a; cf. Figure 1 above), while the latter corresponds to the anterior path postulated by Andrason (2011a, 2011b, 2012a, 2012b, 2013a, 2013b; cf. Figure 2 above). Both maps depict a synchronic state of the *qatal* form.

(a) Coarse-grained map

RESULTATIVE PROPER → PRESENT PERFECT → PERFECTIVE PAST → NON-PERFECTVIE PAST

(b) Fine-grained map

RESULTATIVE PROPER
INCLUSIVE PERFECT
RESULTATIVE PERFECT
EXPERIENTIAL PERFECT
INDEFINITE PERFECT
HODIERNAL PAST
HESTERNAL PAST
RECENT PAST
GENERAL PAST

PERFECTIVE PAST

NON-PERFECTIVE PAST
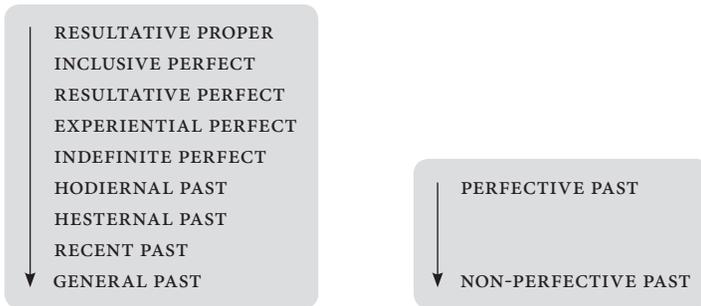
Figure 3: Maps of the synchronic state of the *qatal* form (Andrason 2013a, 2015)

4. Interim conclusion

Universal paths substantially diverge from concrete realistic developmental processes, establishing only the order of incorporation of new senses. While realistic grams accumulate senses, paths formulate no prediction with regards to the extent of such an accumulation. Paths should hence be understood not as representations of realistic evolutionary cases but rather, by codifying the order of incorporated meanings, as models of principia governing such evolutions. They can also be used as templates to map the synchronic states of grammatical constructions. Following this interpretation, paths can be viewed as universal rules that operate deterministically. However, their validity is universal at an abstract and theoretical level, where all the noise or "friction" is ignored and where the system is profoundly idealized.

Knowing the epistemological status of traditional paths, a new question arises: How can we represent realistic evolutionary cases? How can we formulate a model that would represent the sequence of stages in the development of real-world grammatical formations? In the next paper – the last of the series – I will demonstrate that realistic evolutionary stages are points on state-space. This state-space draws from a new understanding of paths, namely from their view as matrices of the sematic potential of grams. The conceptualization of the grammatical life of verbal constructions as chaotic will enable me to provide an explanation of all possible developmental cases, including the most anomalous.

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