FACULTADE DE FILOLOXÍA

DEPARTAMENTO DE FILOLOXÍA INGLESA E ALEMÁ

Structure dependence, English Grammar and Universal Grammar

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Grao en Lingua e Literatura Inglesas

Liña temática: Lingüística e procesamento das linguas. Aplicacións

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Introduction

It is a widely accepted fact that many things about linguistic behavior are yet to be satisfactorily explained by linguists. Among these, the discussion on the possible sources of linguistic knowledge is to be highlighted. This debate, which is still on-going in contemporary linguistics, has long been of interest to me. Whether certain aspects of linguistic knowledge are innate or whether they are learned from the environment is a complex question which still goes unanswered, despite the many academic efforts that have been made to support one view or the other.

Linguistic innateness hypothesis argues for the existence of innate linguistic knowledge in the human species (*Homo sapiens*). This linguistic theory is closely linked to Generative Grammar – one of the most influential formal approaches in linguistics. Being highly intrigued by the enormous potential that formal approaches have for grammatical analysis, my intention was to explore the relation between English Grammar and the theory of linguistic innateness. I was able to achieve this by focusing my argument on one crucial aspect of syntax known as structure dependence, which has been considered by linguistic innateness theory to be an innate linguistic principle. Structure dependence is a key property of all grammars, including English, as it accounts for the hierarchical nature of language.

The aim of this work is twofold: (i) to present a thorough revision of structure dependence in relation to English Grammar from the point of view of linguistic innateness hypothesis, and (ii) to offer relevant criticism of such a theory, with the intention of providing a constructive and critical evaluation of the methodology and claims of linguistic innateness hypothesis. For this purpose, I have consulted numerous works from a wide array of authors, each of them notorious in their corresponding field of inquiry. Out of the many scholars whose works I have referred to, Noam Chomsky is to be highlighted, as he is the main theoretical defender of linguistic innateness theory.

This revision of linguistic innateness and English Grammar is organized in five sections. In section 1, I set the grounds for the introduction of linguistic innateness theory by focusing on the presentation of the 'rationalism vs. empiricism' dichotomy, since rationalism is the undeniable predecessor of linguistic innateness hypothesis. I also provide a scientific

update of the aforementioned philosophical trends by resorting to current biology and the cognitive sciences.

In section 2, I provide an ample description of linguistic innateness hypothesis by presenting its basic tenets, its biological and cognitive assumptions, and its main arguments. The formulation of Universal Grammar (i.e. the set of innate principles that linguistic innateness theory argues for) will be likewise presented. The introduction of Universal Grammar is of crucial importance, since one of the principles which is supposedly contained by it is precisely structure dependence.

In section 3, I offer a description of the most important argument utilized to support claims of innateness, known as the Argument from the Poverty of the Stimulus. This argument is critical in the postulation of structure dependence as an innate principle. Afterwards, a thorough definition of structure dependence in relation to English Grammar (and more precisely, English syntax) is introduced. For this purpose, examples and analyses of yes-no question formation will be offered. Subsequently, I also present a review of some experiments which tested children's supposed innate knowledge of structure dependence through yes-no question production. Their results, which tentatively support the view that structure dependence is an innate principle of human language, will be likewise presented.

In section 4, I introduce criticism on both the methodology and the claims of linguistic innateness theory. In this manner, I present a brief review on the conclusions reached by several authors who, by resorting to evidence found in English language corpora, reject the premise that structure dependence is innate. Contrary to these conclusions, I subsequently offer a possible confirmation of the claim of innateness concerning structure dependence, which is also based on empirical data withdrawn from corpora.

Finally, in section 5, I advance a brief critique on the notion of 'innateness' that linguistic innateness hypothesis relies on by resorting to current findings within the field of developmental biology. Thus, I challenge the notion of 'innateness' that linguistic innateness depends upon by explaining its flaws from a biological perspective, while also defending the view that a more biologically accurate notion of innateness is possible and certainly applicable to linguistic innateness hypothesis.

1. Scientific and philosophical background

In this section, I will provide a brief overview of the bases of both rationalism and empiricism, the two philosophical trends which dominated Western thought during most of the Modern era. These two major – and for the most part, opposing – theories are the philosophical predecessors of current nativist and empiricist scientific approaches. As such, a short exposition of their principles is crucial for the comprehension of the state-of-the-art in contemporary linguistics, especially regarding the theory of linguistic innateness that will be explored in sections 2 and 3.

Subsequently, I will also offer an update of this traditional opposition by resorting to current general biology and the cognitive sciences. The presentation of current scientific correlations of traditional rationalism and empiricism is of great importance when it comes to the consideration of language, since these trends dominate contemporary scientific studies. Furthermore, a thorough and accurate exploration of language and its properties cannot but found itself on facts drawn from studies of the brain; for the brain/mind is the ultimate base of language. With this purpose, the most recent developments in the fields of cognitive science and biology will be presented, especially in relation to three pivotal concepts: learning, innateness and models of mental architecture. Lastly, it should be noted that the content provided within this section will have a very broad span, not referring to linguistic matters in particular, but to issues regarding knowledge and cognition in general.[1]

1.1 Rationalism vs. empiricism

Firstly, it should be noted that 'rationalism' and 'empiricism' are not labels that denote specific and unified theories, but rather names that refer to two broad philosophical trends (Schwartz 1999:703). It must also be taken into account that, despite being mainly opposing theories, rationalism and empiricism did share some common ground.

[1] These, in turn, yield consequences that also apply to language.

Although rationalist academics are traditionally better known to have stressed the notion of *idea* over empiricist philosophers, in reality both trends relied on the existence of ideas as produced by the mind. Furthermore, both sides assumed a mentalist approach to psychology, since they agreed "that the coin of the mental was ideas, and the empiricists' ideas were no less representational than those of the rationalists" (Schwartz 1999:704).

There were, notwithstanding, vast differences between the two trends. Rationalist and empiricist views mainly differed in their position regarding the nature and function of experience when it comes to the acquisition of knowledge. On the one hand, empiricism held the opinion that all knowledge comes from experience (Schwartz 1999:703). Empiricist theories were founded upon the assumption that factual knowledge is learned and depends on experience which is gained inductively, so that the mind, at birth, is like a "tabula rasa" (Schwartz 1999:703–704). On the other hand, rationalism maintained that experience is not at the base of all knowledge, for "[s]ome concepts are neither derived nor *derivable* from sense experience" (Schwartz 1999:704; my italics). According to this perspective, the mind comes furnished with a set of innate ideas (Schwartz 1999:704); this means that at least a portion of knowledge is not taken from the environment, but *native* to the organism.[2]

In spite of the clear clash between these two doctrines, it is convenient to keep in mind that, with the passing of time, new understandings of pivotal concepts such as mental architecture, learning or innateness have allowed these theories to change in such a way that their differences have become blurred. Thus, scientific developments account for the fact that rationalism and traditional empiricism are no longer up-to-date philosophical or scientific approaches. However, the dichotomy between their current counterparts – nativism for rationalism, and present-day empiricism – has been widely maintained, since contemporary researchers still ascribe their work primarily to one or the other.

[2] The view that some forms of knowledge are innate or native is precisely the strongest and most significant link between traditional rationalism and current innateness or nativism – hence their names.

1.2 Cognitive and biological update: mental architecture models, innateness and learning

Divergent understandings of some key concepts and phenomena by nativists and empiricists have produced two radically different answers to two crucial questions, namely: (i) what is the role of experience in the acquisition of knowledge? and (ii) what is the *nature* (either innate or learned) of this knowledge? Thus, the definition of the aforementioned key concepts and the introduction of up-to-date findings within the fields of biology and cognitive science are critical in order to situate the contemporary debate – and opposition – between nativism and empiricism.

Current cognitive science is mainly concerned with the formulation of models of mental architecture, i.e. models that explain how the internal wiring of the brain/mind functions. These models follow one of two major tendencies: either modularity, or general intelligence. This dichotomy mirrors the 'rationalism vs. empiricism' opposition that is also traditionally present in many other scientific fields. Modularity is the nativist proposal – since it normally argues for innateness –, while general intelligence is the empiricist one – since it normally argues that knowledge comes from experience. Nevertheless, it should be noted that virtually all theories of cognitive development grant children some – although fairly limited – innate abilities, such as those of forming associations (Gelman 1999:128). There are, however, far more points of contention than of agreement between the two theories, as we will now see.

Generally, models with empiricist inclinations maintain that the mind of the infant is a "blank slate" (Gelman 1999:128). For them, the mind engages in inductive learning processes, thus deriving knowledge from experience. These cognitive models emphasize the existence of a general intelligence that is applied to *any* cognitive task, regardless of specific content (Gelman 1999:238). This is what we understand as domain generality. According to this general cognitive architecture, "the mind/brain is a general-purpose solver" (Karmiloff-Smith 1999:558) that relies on experience in order to produce knowledge, doing so in a concrete-to-abstract manner.

Contrary to domain-general theories of cognitive abilities, nativist theories – considered "modern instantiations of rationalism" (Gelman 1999:128) – do grant children some innate knowledge to begin with by relying on the theory of modularity. Modular theories hold that there is domain specificity in the architecture of the mind. This means that the "mode of reasoning, structure of knowledge, and mechanisms for acquiring knowledge differ in important ways across distinct content areas" (Gelman 1999:238). In other words: the brain is, according to this view, made up by a number of modules whose cognitive skills are domain specific (Karmiloff-Smith 1999:558). These modules are generally thought to be "innately constrained, biologically determined, and invariant" (Gelman 1999:239).[3] As a result, a given cognitive skill must be processed by the particular cognitive module that it belongs to; and this processing must occur separately from that of other modules. To put it simply, modules cannot operate interchangeably because their cognitive abilities are domain specific.

Language acquisition and processing has been claimed by some to be one of the best-known instances of domain specificity. Supposedly, the manner in which language is 'learned' differs greatly from the manner in which other cognitive skills are developed (Gelman 1999:238). Moreover, and according to modular theories, the development of linguistic cognitive skills appears to be irrelevant when it comes to the acquisition of knowledge in other domains (Reisberg 1999:461). This would denote modularity and domain specificity of linguistic mental processes according to a modular theory of mind (Gelman 1999:238).

Modularity of mind is closely linked to nativist theories in biology. Nativism works upon the assumption that a notable percentage of knowledge is "built in" to an organism, or at least innately predetermined, in a way that allows it to more easily engage in some behaviors as opposed to others (Keil 1999:583–584). Roughly put, nativism heavily relies on

[3] Although modules are normally considered to be innate and biologically determined, this is not always the case. Chomskyan linguistics and Fodorian modularity are probably the best examples of modular theory (Gelman 1999:238); these argue for innateness and genetic determination. It should be noted, however, that "[d]omain-specificity is not a single, unified theory of the mind," for there are at least three distinct approaches that assume it and only one of them – modular theory – accepts genetically-predetermined modules, i.e. mental structures or systems which are innately specified (Gelman 1999:238). In fact, celebrated contemporary authors such as Karmiloff-Smith hold that modularity is the product, and not the initial state, of development (1999:559–560). Consequently, Karmiloff-Smith's proposal, although modular, would not be a *nativist* one.

the existence of "multiple learning systems[,] each of which is especially effective at acquiring a particular kind of information" (Keil 1999:584). This fits well with the definition of modularity as formulated by the cognitive sciences.

The concept of 'innateness' in nativist theories is a key aspect that clearly differentiates them from empiricist ones. Innate theories in their strong formulation argue for the existence of a set of characteristics or principles that are native to the organism, which can take abstract forms. Following nativism, infants could and would need to have access to innate abstract principles in order to learn. Needless to say, innateness in its strong formulation is vigorously rejected by empiricist theories, for the hard core of empiricism states the precise opposite: that organisms gather knowledge exclusively from exposure to data.

This is the major debate *par excellence* in cognition today: whether organisms achieve knowledge due to their general cognitive capacities, or whether they are endowed with a set of predetermined and specialized structures that enables them to acquire a particular type of knowledge in a particular manner (Keil 1999:584). This conflict is very much linked to the concept of learning. In fact, the core of the 'nativism vs. empiricism' current debate lies in the disagreement over the *nature* of the organism's learning processes. To put it simply, there is virtuallyno doubt about the *existence* of learning processes and mechanisms. Controversy mainly arises when trying to establish a limit to the effect and function of experience and learning on the final product: knowledge. For that reason, a specialization on the notion of learning must be presented.

Admittedly, Reisberg (1999:461) indicates that the term 'learning' covers a high number of phenomena, which can prove to be rather confusing. We will confine our argument to the exposition of learning by induction, a phenomenon in which "the learner is exposed to a series of stimuli or events and has the opportunity to discover a general rule or pattern that summarizes these experiences" (Reisberg 1999:461).[4] This type of learning process heavily relies on experience, from which knowledge is derived, according to empiricists. In fact, language acquisition is viewed by many as an exemplary case of learning by induction (Piaget 1980a:23–24, 1980b:58–59).

[4] It should be noted that the discovery of a 'general rule' or 'pattern' and its exceptions is what is at stake at most stages of language acquisition.

Contrary to this view, Piattelli-Palmarini (1989:1) defends the thesis that 'learning' in the traditional "instructive" sense simply does not exist. In his work, highly influenced by biology and modern Generative Grammar, Piattelli-Palmarini (1989) makes a clear distinction between learning by instruction and learning by selection. Learning by instruction is, in theory, "a transfer of structure *from* the environment *to* the organism" (Piattelli-Palmarini 1989:2). Undeniably, this type of learning process is at the base of most, if not all, empiricist theories. This is true especially regarding their characterization of experience, which they hold to be the source of knowledge; for, according to empiricism, the mind is a "tabula rasa" or 'blank slate' at birth (Schwartz 1999:703). In Piattelli-Palmarini's views (1989:2), however, instruction is simply untenable; apparently, no such transfer – or "assimilation", or "interiorization" – from the environment to the organism can occur.

Learning by selection is, however, a radically different process. In fact, it is not a type of 'learning' at all, if learning is understood in the traditional sense, i.e. the previously mentioned transference from the environment to the organism. Like other nativists, Piattelli-Palmarini (1989:3) argues for the existence of innate predispositions; according to him, 'learning' by selection rests on certain internal mechanisms that select and filter the data. In fact, according to traditional biology, "constraints thought of as 'canalization' are the best way of understanding innateness" (Keil 1999:584). In addition, it is said that all the mechanisms involved in acquisition studied by biology and the cognitive sciences have been thought to be due to a process of internal selection (Piattelli-Palmarini 1989:2). So nativism proposes the existence of innate properties that are biologically predetermined; notwithstanding, the final outcome of the acquisition process need not be pre-specified, since development may be diverse due to environmental differences (Piattelli-Palmarini 1989:3). By relying on concepts such as 'learning by selection' and 'innateness,' nativism is able to account for variability, while also maintaining that learning by selection provides "the best *scientific* explanation for variability and diversity" (Piattelli-Palmarini 1999:3; my italics).

All in all, it is indisputable that the 'rationalism vs. empiricism' dichotomy has come a long way over time. Previous rationalist arguments for innateness claimed that certain ideas must be innate because there is no possible evidence of them in the natural world. Contrary to that reasoning, contemporary nativists extend the claim of innateness to ideas for which

there are observed cases, by stressing inductive indeterminacy (Schwartz 1999:704).[5] This leads us to the contemporary debate on language: although empiricist theories reassure that there is enough data for the child to acquire a language, nativist academics maintain that there is not. The argument about the insufficiency of linguistic experience is commonly known as the Argument from the Poverty of the Stimulus – henceforth APS. This argument is key within nativist theories, and it will be explored in detail in the following sections. Briefly put, it comes to state that language acquisition must be partly "dictated by innately given learning mechanisms" (Marcus 1999:661), defending the existence of innate knowledge.

Authors who support modularity theory, such as Chomsky, agree that there are innately given constraints, and also that these are specific to language (Crain 1991:611; Karmiloff-Smith 1999:558). Chomsky, along with other scholars, has become the main representative of linguistic innateness hypothesis, a nativist theory that argues for the innateness of language within the human species. A detailed exploration of the principles of linguistic innateness will be offered in the following section (2).

[5] Inductive indeterminacy is the indeterminacy (i.e. insufficiency) of the evidence when trying to draw the correct generalization from the available data.

2. Linguistic innateness

In this section, I will present a detailed depiction of the basic tenets of linguistic innateness. With this purpose in mind, a presentation of its theoretical standpoints will be offered, along with a discussion of the biological and cognitive presuppositions that this theory relies on. Finally, the logical argumentation that comes from the nativist treatment of the APS will lead to the exposition of the most central aspect within innateness theory: the formulation of the set of allegedly innate principles it argues for, known as Universal Grammar.

2.1 The principles of linguistic innateness theory

As we have seen in the previous section, the central assumption of a nativist program is that the environment in itself has no structure; as a consequence, all laws of order – whether cognitive, biological or linguistic – must come from within (Piattelli-Palmarini 1980:10). The foundation of knowledge, then, relies on "universal inborn structures" which allow the organism to *impose* order upon perceptual data, instead of *deriving* order from it – which is what empiricist theories typically hold (Piattelli-Palmarini 1980:10). These "laws of order" are considered by nativists to be invariable over time and across individuals; in other words, they are viewed as species-specific properties and, therefore, as genetically determined (Piattelli-Palmarini 1980:10). This is the base of any nativist program, and linguistic innateness is no exception.

Linguistic innateness hypothesis is one of the most notable actualizations of current nativism. Its proposition relies largely on the work of revolutionary linguist Noam Chomsky, who formulated most of the theoretical components of this hypothesis, along with many of the pivotal arguments that support it (Wexler 1999:408). The core of linguistic innateness relies on the premise that very specific information, i.e. linguistic principles or patterns, are already imprinted in the organism before the environment can reveal these structures (Piattelli-Palmarini 1980:12). To put it simply, innateness theory proposes that linguistic knowledge is "wired in" (Anderson & Lightfoot 2000:698), especially when it comes to *structure* of language. So, defenders of this hypothesis attribute implicit linguistic knowledge

to the human species, maintaining that certain structural aspects of our linguistic capacity are innate, genetically determined, part of our biological endowment and, as such, a true species-specific property (Chomsky 1988:2–3; Hoekstra & Kooij 1988:52).

As a consequence, the learning of a language would result from a specific innate capacity rather than by inductive observation of that language (Anderson & Lightfoot 2000:698). Furthermore, renowned nativists such as Crain & Pietroski (2001:178) have postulated the following:

> [M]any aspects of adult grammar are innate and in place at a very early age. These innate linguistic principles define a space of possible human language – a space the child explores, influenced by her environment, until she stabilizes on a grammar equivalent to that of adults in her linguistic community.

In this manner, language acquisition is thought to be determined by the same genetically encoded principles which delineate the possibilities of human language; these derive from the genetic make-up of the human species (Hoekstra & Kooij 1988). These principles, according to nativists, are abstract in the way that they allow the child to learn *any* language, yet precise in the fact that they meet several restrictions which ultimately characterize the possibilities of human language (Hoekstra & Kooij 1988:45). In other words, innateness hypothesis maintains that our (innate) linguistic capacity is what shapes human languages, and places such constraints on its possibilities for grammar. Therefore, arguments for linguistic innateness cannot be separated from the fact that grammars have idiosyncratic constraints (Crain & Pietroski 2001:159). The logical outcome of this is that properties of specific languages could be derived from (for they would be determined by) those of our innate linguistic knowledge (Chomsky 1988:40). This specific aspect of linguistic innateness theory is stressed particularly in the Chomskyan nativist argument, as Chomsky emphasizes the fact that grammatical operations are governed by specific innate constraints (Crain & Pietroski 2001:164).

2.2 Modularity, the Language Faculty and the APS

Nativist arguments rely on a number of cognitive and biological assumptions that are fundamental to the conception of language acquisition as ‘growth’ rather than ‘learning’ in its inductive sense (Anderson & Lightfoot 2000:710–711). One of them is modularity, that

is: the theory of a specialized, compartment-like brain. Modularity supports linguistic innateness because, as we have seen, the theory of a biologically specialized brain fits well with the hypothesis of having an innate set of specialized linguistic information (Hoekstra & Kooij 1988:42). This is so for the following reasons. Firstly, the nativist argument directly identifies language with grammar, and, more specifically, with syntax (Chomsky 1980a:55–59), thus determining the *type* of linguistic information that is allegedly innate. Secondly, this grammar is said to be one module or subcomponent of the mind, which cooperates with other modules or cognitive capacities in the brain (Anderson & Lightfoot 2000:712). Thirdly, modularity maintains that any module, including the grammar, is likely to have clear initial and mature states, thus accounting for the supposed *a priori* linguistic principles (the initial state) which develop in time and through experience into the mature state (Anderson & Lightfoot 2000:712).[6]

This definition of grammar as one of the brain's modules must not be confounded with the grammar of a language – henceforth G_L – which is defined as a system of rules that explain the empirical data and which we use to communicate with other members of our linguistic community (Chomsky 1980a:75; Hoekstra & Kooij 1988:35). Similarly, 'grammar' as a mental module should not be mistaken by Chomsky's concept of grammar as individual knowledge.[7] Lastly, it is not to be confounded with a generative grammar either, which is the theory or detailed description of the grammar of a language.[8] With the purpose of maintaining clarity, we will from now on refer to the concept of grammar as a mental module by using Chomsky's own label: the Language Faculty – henceforth LF.

Abiding strictly to modularity, innateness hypothesis maintains that the LF has a physiological base, to the point that it could be considered an "organ of language" (Anderson

[6] According to Chomsky (1986:xxvi), linguistic principles do not generalize with respect to other cognitive domains, but are specific to language. Such a supposition is tentative; what's more, the idea that innately given constraints are specific to language has been recently challenged (Marcus 1999:661; Tettamanti & Perani 2012:241).

[7] Chomsky defined 'grammar' as a set of mental rules and representations of a given language; that is, a stable linguistic (i.e. syntactic) competence. It is, therefore, the mature system of knowledge an individual has of a particular language (Chomsky 1988:15, 36–37). This concept is referred to by Crain & Pietroski (2001:139) as 'adult grammar' in a perhaps more elucidating manner.

[8] A generative grammar is a sufficiently explicit theory of a language so as to "predict an unbounded range of structured expressions [which] can be tested for empirical adequacy by investigating the accuracy of these predictions" (Chomsky 1988:61).

& Lightfoot 2000; Chomsky 1980a:60; Frazier 1999:557–558). Chomsky (1988:60) describes the LF as:

> [A] component of the mind/brain, part of the human biological endowment. Presented with data, the child, or, more specifically, the child's language faculty, forms a language, a computational system of some kind that provides structured representations of linguistic expressions that determine their sound and meaning.

According to Chomsky, the LF is said to incorporate "quite specific principles that lie well beyond any 'general learning mechanisms'" (1988:47). It is also thought to be the hypothetical housing of all grammatical operations in the brain, during and after the language acquisition process. Lastly, the consideration of the LF as an "innate property of the human mind" accounts for linguistic innateness' approach to language in terms of human biology (Chomsky 1975:34; Boeckx 2006:67).

Following Chomsky, innate linguistic rules are equated merely to syntactic rules, which are in turn thought to be predetermined by the broad innate principles housed in the LF module. Chomsky's reduction of language to syntax was not only a theoretical standpoint, but also justified empirically by him (1980a:55–59). Through the use of evidence, Chomsky (1980a:59) argued that his theoretical partition paralleled the functional independence that the grammatical competence has with respect to the pragmatic competence. Moreover, other scholars have suggested that the initial separation Chomsky sketched might be corroborated by studies of the brain, supposedly proving that syntax is a specialized and autonomous component of a modular language processor (Anderson & Lightfoot 2000:717; Frazier 1999:557; Smith 1999:24, 133). Consequently, innateness theory proposes a theoretical separation between linguistic rules and other cognitive abilities – even with those that are also concerned with language, as it is the case with the conceptual and pragmatic systems (Hoekstra & Kooij 1988:42–45). In this manner, Chomsky established a necessary correlation between cognitive function (the computational aspect of language, i.e. syntax), its physiological base (the language organ) and the genetic code of the human species (the human genome) (Wexler 1999:408).[9]

[9] According to Chomsky, native principles are expected to be found "physically represented in the genetic code and the adult brain, respectively, with the properties discovered in our theory of the mind" (1980a:82–83). Other authors offer a less drastic viewpoint by stating that linguistic innateness "seeks to identify information which must be available independently of experience, in order for a grammar to emerge in a child" (Anderson & Lightfoot 2000:703). Concerning genetics, they do not claim that such information is encoded in the human genome, since it could also result from epigenetic

Precisely due to its claim of universality, the scientific purpose of linguistic innateness is to explain the internal structure of the universal subject by formulating the set of very intricate and highly specific linguistic structures accessible to the organism (Piattelli-Palmarini 1980:11).[10] To put it simply, this hypothesis intends to define exactly *what* is innate in our linguistic knowledge. The linguist's aim is, therefore, to analyze in depth and characterize in detail an 'ideal speaker' through appropriate abstractions from empirical givens (Piattelli-Palmarini 1980:10). Problems arise due to the consideration of the LF as a mental organ, since it poses several difficulties in its physiological or empirical study. Nevertheless, nativists affirm that, contrary to common belief, innateness is not beyond investigation (Hoekstra & Kooij 1988:47). In theory, linguistic innateness is supposedly supported by linguistic research. Such inquiries are carried out by studying thoroughly the logical possibilities of linguistic facts, which are drawn from linguistic data. In fact, innateness hypothesis maintains that only by extensive and detailed linguistic analysis about language structure – the principles of human grammars – can linguists realistically address the question of whether these principles can or cannot be learned or drawn from experience, or whether they must be innately specified (Crain & Pietroski 2001:140). This is precisely the theoretical standpoint that is behind the experimental study of structure dependence, an aspect of English Grammar which will be presented in section 3.

So proponents of innateness have attempted to demonstrate that the stable states children achieve – adult grammar – are underdetermined in theoretically important respects by the linguistic input they receive (Crain & Pietroski 2001:139). Nativists hold that the primary linguistic data – henceforth PLD – available to children are insufficient for them to acquire the mature knowledge of language that they do gain once the process of language acquisition is over. This would still remain true, apparently, even given optimistic assumptions about the nonlinguistic capacities of children, especially the capacities to form and test generalizations based on their experience (Crain & Pietroski 2001:139, 153). This form of inductive indeterminacy is a "problem of under-determination of theory by data, applied to language learning" (Marcus 1999:660). Within linguistic innateness theory, the

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and developmental properties of the organism; notwithstanding, despite various doubts regarding domain specificity or genetic determination, nativists have no doubt that such innate constraints exist (Anderson & Lightfoot 2000:703; Crain 1991:597; Lightfoot 1999:62; Marcus 1999:661).

[10] A universal subject is a prototypical individual of the human species.

insufficiency of the PLD is commonly referred to as the APS or Plato's problem. This is a pivotal and necessary argument that would, if proven to be true, provide irrefutable support to linguistic innateness.

If we accept that there is indeed poverty in the linguistic data, the crucial but *limited* role of experience in language acquisition would be logically derived from this argument. In this case scenario, experience would provide fundamental data in the process of language acquisition; it simply would not be the source of *all* linguistic knowledge (Chomsky 1980a:66). According to nativists, the child's PLD does not provide the basis for attaining certain aspects of linguistic knowledge; therefore, "another source must exist for that knowledge" (Anderson & Lightfoot 2000:710). In order to fill the empirical gap that the APS proposes, theoretical linguists have formulated a rich system of linguistic principles which would constitute the innate aspects of our linguistic knowledge, thus making language acquisition possible in spite of impoverished data. This is Universal Grammar.

2.3 Universal Grammar

Universal Grammar – henceforth UG – is the theory that explains the internal organization of the LF at the initial state (Crain 1991:598). It is a structural characterization of the genetically-determined LF that includes its *specific* components (Chomsky 1986:3, 1988:61). The content of UG is the "body of 'hard-wired knowledge'" that takes part into the operation of the LF, reflecting its general computational properties (Chomsky 1988:25, 61; Pesetsky 1999:476). To put it simply, UG is the set of 'unlearnable' native grammatical principles that govern human language; these constraints are broad and universal (Chomsky 1988:3; Crain 1991:598, 611; Hoekstra & Kooij 1988:45).[11]

The properties of UG impose severe restrictions on the type of possible human grammars, thus accounting for the fact that many of its principles are thought of as constraints (Chomsky 1980a:66). UG is a system of conditions on possible grammars; the principles of UG provide both a restrictive and schematic model to which languages do conform, as well

[11] These principles are characterized as 'unlearnable' by innateness theory due to the claims that nativists make concerning the APS: as we have seen, some aspects of language cannot be *learned* from the PLD, and as such, they are 'unlearnable.'

as certain heavy constraints that determine how grammars can function (Chomsky 1968:63). In this manner, possibilities of linguistic diversity are narrowly limited by the principles of UG, so that no natural language can exist if it violates these conditions (Anderson & Lightfoot 2000:706). This is so because properties of the UG "reflect innate features of human grammars" which hold universally (Crain & Pietroski 2001:152).

Additionally, although it may seem contradictory at first, the systems that make up UG also account for linguistic diversity and variability in structure (Chomsky 1980a:66–67). There are several theories which justify how variation is incorporated into UG; the proposal that is closest to Chomskyan linguistics involves the abidance to a binary parameter-setting model (Pesetsky 1999:477). This kind of parameter-setting model understands UG as a system composed of unifying principles or constraints, and a number of parameters (Chomsky 1980a:66). On the one hand, parameters are made up by a limited and ordered series of hypotheses or values, representing a purported universal syntactic principle; according to a binary parameter-setting theory, parameters are constituted by both an unmarked and a marked value (Crain 1991:601; Crain & Nakayama 1987:541). During language acquisition, the child's task is to set the parameters with the correct value of the target grammar in the view of the positive data that they receive (Crain & Nakayama 1987:541). On the other hand, constraints are not parameterized because they represent only one possibility, as opposed to parameters, which represent at least two; in this manner, constraints strongly delimit certain aspects of grammar which are said to be completely universal (MacWhinney 2004:888).[12] The structure of Chomsky's parameter-setting model of UG allows for the fact that setting a particular parameter may, in turn, set other parameters, thus having repercussions throughout the child's grammatical system (Crain & Nakayama 1987:541). The content of UG, therefore, is considerably rich in its deductive structure, but with: (i) parameters that remain open to be fixed by triggering experience, and (ii) constraints that delimit the possibilities of human language (Chomsky 1980a:66; Hoekstra & Kooij 1988:39). Notwithstanding, the principles of UG are not *derivable* from the data, for although UG does specify a series of parameters, the values in which they can be set vary across languages (Hoekstra & Kooij 1988:39). In other words, UG is made up by general properties

[12] One purported constraint contained by the theory of UG is structure dependence, a property which will be explored in detail in section 3.

of language, although the concrete realization of those abstract forms differs from language to language (Chomsky 1988:14). Logically, it follows that the grammars of all natural languages "share a common core" (Hoekstra and Kooij 1988:35). This necessary plasticity imposes quite a strong empirical demand on the theory of UG, yet it is supported by the supposed deep similarity among the world's languages (Anderson & Lightfoot 2000:703, 715).

Anderson & Lightfoot (2000:703–704) define UG as a 'biological entity' for, in fact, its characterization within innateness hypothesis cannot be attained without resorting to general biological terminology. Since UG is the initial state of the language learner (i.e. the initial state of the LF, before it has been presented with linguistic data), it must also be the basis on which language develops (Chomsky 1980a:69, 1988:61). As such, the set of innate properties that constitute UG must be genetically determined in the human genome, i.e. the entire genetic material or DNA of the species (*Homo sapiens*) (Wexler 1999:408). Logically, these genetically-determined principles should also be part of every individual's genotype, i.e. the organism's particular DNA (Jablonka & Lamb 2005:28). In turn, the genotype delineates the possibilities or potential of the organism's development into the phenotype, i.e. the individual's specific characteristics (Jablonka & Lamb 2005:28). That means that the same genotype could potentially develop into several phenotypes. However, these possibilities are not endless, for they are prepared for and limited by the genotype of the organism. As Anderson & Lightfoot explain, "[e]ach individual's genotype determines the potential range of functional adaptations to the environment" (2000:703). Were UG to be part of the species genome, all prototypical humans would have the same linguistic potential for functional adaptations into *any* particular grammar, depending entirely on the PLD offered to them and not at all on variation in their genetic make-up (Anderson & Lightfoot 2000:703). To sum up, innateness hypothesis assumes that the linguistic genotype or UG is uniform across the species, given the absence of severe and specific pathology (Anderson & Lightfoot 2000:703; Boeckx 2006:68).

Thus, UG allegedly determines the possible paths of maturation from the initial state to a specific mature state (the actual grammar of a particular language, or G_L). UG, then, is a genotypic determination within the organism; environmental differences bring about phenotypic variation which account for linguistic diversity and the possibility that any person

might acquire any natural language (Hoekstra & Kooij 1988:38). As Chomsky points out (1988:65),

> [T]he languages of the world appear in all sorts of respects, but we know that they must be cast from the same mold, that their essential properties must be determined by the fixed principles of universal grammar. If that were not so, it would not be possible for the child to learn any one of them.

At this point, it should be stressed that experience does provide relevant data for the choice of values in the parameters, assuming a fundamental but *passive* role in language acquisition; to put it simply, "environmental stimulus is just a trigger" (Lightfoot 1999:64). What's more: it is assumed that if the UG or initial state is rich enough, even limited data will produce a highly articulated system of rules in the organism, i.e. an adult grammar (Chomsky 1980a:66). In conclusion, linguistic innateness holds the view that human language arises "in biologically based ways that are quite comparable to those directing other aspects of the structure of the organism" (Anderson & Lightfoot 2000:700; Chomsky 1986:2).[13] Therefore, the construction of a theory of UG would be the solution to the APS (Chomsky 1988:61).

There is quite a number of empirical evidence that plausibly validates the existence of UG (Pesetsky 1999:476–478). The most obvious one would be identification of linguistic universals through cross-linguistic research. Linguistic universals are principles or patterns that appear recurrently in the world's languages and are, quite logically, predicted by the theory of UG (Hoekstra & Kooij 1988:45). Another possible evidence of UG would be the rapid rate at which language acquisition takes place, along with the existence of a critical period for language learning (Anderson & Lightfoot 2000:710; Hoekstra & Kooij 1988:36; Meisel 2013). Moreover, innateness hypothesis in general seems to be supported by evidence that some language deficits "show a clear distribution within families that epidemiological and other studies show to be just what would be predicted of relatively simple heritable traits" (Anderson & Lightfoot 2000:699). In addition, the development of structurally poor pidgins into creoles also appears to be another source of evidence of the existence of UG, since this reorganization supposedly involves the implementation of principles found precisely in this theory (Anderson & Lightfoot 2000:716; Pesetsky 1999:478). In relation to this, the fact that there exist deep structural similarities between oral and signed languages could also be

[13] It is in this vein that Lightfoot boldly characterizes language acquisition as "language *growth*" (1999:64; my italics).

further proof of the existence of UG (Anderson & Lightfoot 2000:715). All things considered, a logical solution to all of these problematic phenomena could well be founded upon the existence of native knowledge of linguistic principles or UG.

Notwithstanding, although such facts *could* potentially corroborate the hypothesis of a UG, they are not necessarily conclusive. If linguistic innateness were to be unerringly confirmed, a *decisive* form of evidence should be utilized to support it. It is precisely the APS that we had previously sketched what provides the crucial argument for innateness hypothesis, which is why it plays such a central role in the formulation of linguistic innateness (Wexler 1991). As we have seen, linguistic innateness hypothesis maintains that there is a mismatch between the poor input received by children and their advanced knowledge of language; in order to bridge the gap, this theory postulates the existence of innate linguistic mechanisms. With the purpose of exploring the logical argumentation behind the theory of UG – which is the core of linguistic innateness –, a further analysis of the APS will be presented in the following section (3).

3. The APS and structure dependence

In this section, I will provide a detailed description of the APS, owing to its centrality within linguistic innateness theory (Wexler 1991:268). The three different levels of indeterminacy that the APS deals with will be presented, along with the implications that these have regarding language acquisition. Special attention will be paid to the third level of data deficiency, since linguistic innateness states that this is the only conclusive one.

Subsequently, one of the most studied features of (human) language, structure dependence, will be presented. This is a crucial property of syntax that accounts for the fact that language operates hierarchically, and not linearly. It will be defined here as opposed to structure independence (i.e. linear order). The introduction of structure dependence in the discussion with regard to the APS is essential, since nativists have identified this aspect of language as one case of the third data deficiency, i.e. a feature of language for which there simply is no evidence in the PLD.

Finally, I will offer a review of some experiments that test children's knowledge of structure dependence at various stages of language acquisition. These experiments were conducted in English, and they utilized aspects of English Grammar that evidently rely upon structure-dependent rules, as it is the case with yes-no question formation. Their results, which bear consequences regarding the innate constraints supposedly contained by UG, will be likewise presented.

3.1 The threefold nature of the APS

It is quite a remarkable fact that only human infants are capable of acquiring a rich and deeply structured language, and that they do so quite automatically and rapidly, without careful instruction, effort or conscious thought (Berwick et al. 2012:19; Hornstein & Lightfoot 1981:9; Lightfoot 1999:64). It has been claimed that children come to master a system that supposedly exceeds by far that of the data to which they had been exposed (Berwick et al. 2012:19; Marcus 1999:661). As we have seen in section 2, nativist accounts of language acquisition attempt to provide the set of innate principles that make it possible for a child to

acquire a language. Such innate principles must exist because there are certain aspects of grammar which have been identified as putatively 'underivable' from data, owing to the nativist consideration of the PLD as an insufficient inductive base for language acquisition (Chomsky 1975:30; Hornstein & Lightfoot 1981:9). This nativist assumption, that language acquisition takes place on the basis of degenerate and finite data, is often referred to as the APS (Hornstein & Lightfoot 1981:9).

The APS is "the most powerful theoretical tool" to argue for innate linguistic knowledge (Wexler 1991:268). Commonly associated with Generative Grammar, it has been considered to be Chomsky's main argument in the formulation of innateness hypothesis (Wexler 1991:252, 268). It assumes that environmental data is not rich enough to enable children to develop full language competence (Wexler 1999:408). However, in spite of these environmental deficiencies, language acquisition is still achieved.

Although the exact formulation of the APS varies, a typical version states the following (Marcus 1999:660):

> (1) children rapidly and […] uniformly acquire language; (2) children are only exposed to a finite amount of data; yet (3) children appear to converge on a grammar capable of interpreting unfamiliar sentences.

Consequently, it is argued that at least some aspects of grammar are innate (Marcus 1999:660).

It should be noted that the APS is threefold, in the sense that three levels of data deficiency have been identified (Hornstein & Lightfoot 1981; Lightfoot 1999:60). Firstly, the child's PLD consists of a linguistic input that is not always grammatical, for well-formed sentences often coexist with unfinished or defective constructions (Hornstein & Lightfoot 1981:9). This poses a notable issue for the child who faces the task of generalizing to the set of grammatical rules of their target language, for pseudo-sentences are not marked as defective in the PLD (Lightfoot 1999:60).

Secondly, the child is exposed only to a limited number of utterances; in fact, many grammatical sentence-types simply never appear in the PLD of a particular child (Hornstein & Lightfoot 1981:10). In spite of this, they are able to derive a grammar that can deal with an "infinite range of novel sentences, going far beyond the utterances actually heard during

childhood" (Hornstein & Lightfoot 1981:9).[14] In short, the child's experience is finite, yet their mature linguistic capacity "ranges over infinity" (Lightfoot 1999:60). This fact seems to indicate that the PLD or stimulus alone cannot be held accountable for the full determination of mature capacity (Lightfoot 1999:60).

Thirdly, and most importantly, it is claimed that children acquire knowledge about the structure of language for which there simply is no direct evidence at all (Hornstein & Lightfoot 1981:9). According to Crain & Pietroski (2001:152), there is early emergence of certain constraints in child grammars; arguably, these have no matching evidence in the PLD. The assumption, thus, is that children respect certain grammatical constraints "before they are *plausibly* exposed to the data" (Crain & Pietroski 2001:150). Moreover, they do so in spite of lacking adult explanations about ungrammaticality, ambiguity or relation between sentences (Wexler 1991:255). Nativists base this assumption on children's judgment of ungrammatical utterances, rare and complex sentences, and relations of ambiguity and paraphrase, among others (Hornstein & Lightfoot 1981:9).

These three levels of data deficiency place a 'learnability' problem as to how all children come to the same generalizations about their grammars uniformly and universally – in the absence of severe pathology – and without special correction or instruction (Anderson & Lightfoot 2001:697; Crain & Nakayama 1987:526; Marcus 1999:660). It has often been claimed by nativists that there are not enough (in number, or good enough in quality) corrections offered by adults to children to instruct them about their grammatical errors (Crain & Nakayama 1987:526–527). However, even if reliable parental correction were available to children, innate constraints would still be necessary in order to account for the fact that many possible incorrect hypotheses about grammar are simply never tested in the first place; for it seems that children only commit a very narrow range of logical errors during the language acquisition process (Lightfoot 1999:63; Marcus 1999:660). In fact, Lightfoot states that the "non-adult sentences formed by very young children seem to be few in number

[14] As Lightfoot points out (1999:50, 61), our childhood linguistic experience only provided us with positive data, lacking explicit information about negative data, i.e. where the generalizations break down, or knowledge of the exceptions. This information is crucial in the delimitation of grammatical rules (Boeckx 2006:73). Without uniform knowledge of rules and their exceptions, it would not be possible for all children to hit on the same target grammar. Surprisingly, this is undeniably the case, since all children from the same linguistic community derive exactly the same generalizations despite variation on their PLD and personal background (Lightfoot 1999:50).

and *quite uniform from one child to another*, which falls well short of random hypotheses," thus suggesting the existence of a common initial state or UG (1999:64; my italics).

The first two minimal assumptions from the APS – the imperfection and finiteness of the PLD (Lightfoot 1999:61) – are favorable, yet not *conclusive*, when it comes to the corroboration of innate linguistic knowledge. However, the third data deficiency proposed by the APS is much more restrictive than the previous two: it states not that linguistic experience is degenerate, but that in certain areas it is nonexistent (Lightfoot 1999:61–64). In fact, the importance of the third data deficiency is such that the APS would still hold even if the first two deficiencies did not (Hornstein & Lightfoot 1981:13). It relies on the fact that children abide by grammatical constraints at an early age, never testing other logical hypotheses which could be compatible with their PLD (Crain & Pietroski 2001:150).[15] Therefore, since children do attain knowledge of grammars which are purportedly underdetermined by the PLD (so that there is no inductive base to account for some of the properties of such grammars), another source must exist for their acquired knowledge: the native principles proposed by linguistic innateness (Hornstein & Lightfoot 1981:12). It is this *a priori* knowledge what actually circumvents the third data deficiency, so that the fact that the PLD is finite or degenerate does not pose a real problem for children, because they do not depend entirely on the data to acquire the G_L (Hornstein & Lightfoot 1981:12–13).

To sum up, innateness hypothesis states that there must exist a set of innate linguistic principles which make it possible for a child to learn underdetermined properties of language in spite of the APS; such properties must be part of the rich initial state or UG and be available to the child independently of linguistic experience (Chomsky 1975:30, 1980a:87; Lightfoot 1999:62; Wexler 1991:264). These innate linguistic properties have been claimed to appear universally and, most importantly, while lacking decisive data from the environment (Crain 1991:597).

After Chomsky's application of the APS to language acquisition, linguists have attempted to discover those 'unlearnable' constraints through careful study of certain aspects of language. In order to explore those principles, scholars have focused their attention not on the initial state, but on later ones – particularly, the mature state or adult grammar (Chomsky

[15] This indicates that language acquisition does not seem to be based on an exercise of mere trial and error (Lightfoot 1999:64).

1980b:39).[16] Some properties of syntax have been reported to have very little, if any, corresponding evidence from the PLD, which would support nativists' view that the construction and expression of grammatical rules is innately constrained (Crain 1991:597, 611; Crain & Nakayama 1987:522). Among those constraints, the most important one is structure dependence.

3.2 Structure dependence and English Grammar

Linguistic research based on the APS has been closely identified with the study of structure dependence, a key property of language (Chomsky 1986:7). This is so because structure dependence (i.e. the hierarchical, not linear, nature of language) is viewed as an exemplary case of a grammatical constraint which cannot be derived directly from the PLD (Boeckx 2006:70; Crain 1991:602). According to the theory of UG, innate constraints establish limitations to the ways in which languages may vary, thus reducing both the number and kind of grammatical hypotheses that children make during language acquisition (Crain 1991:600). If the knowledge of constraints is innate, then error-free learning of those particular aspects is expected (MacWhinney 2004:888).

As a putatively innate – and thus, universal – constraint, structure dependence characterizes the grammars of all the world's languages; therefore, it also determines many aspects of English Grammar (Chomsky 1975:33). In fact, most investigations regarding structure dependence have employed syntactic rules of English Grammar in order to design experiments which test children's knowledge of such a constraint. In order to accurately tackle such research, a proper definition of structure dependence (as opposed to structure independence) is needed.

[16] The theory of UG assumes that constraints which characterize the initial state are also present in the final or mature state (Crain 1991:599). Therefore, the study of later stages of language acquisition would allow linguists to explore the initial or purely native state of the language learner indirectly (Crain 1991:599).

3.2.1 Structure dependence: definition and relation with the APS and UG

As its own name indicates, structure dependence is a property that deals with the *structure* or computational characteristics of language. The rules of language are structure dependent because they depend on the structure of constructions and their constituents in order to operate (Chomsky 1988:45). This means that the structure of language has a hierarchical (i.e. non-linear) organization (Chomsky 1988:45). Contrary to structure dependence, systems which rely upon structure-*independent* rules include operations that are contingent on linear order, lacking hierarchical organization (Crain & Nakayama 1987:522; Crain & Thornton 1998:165). So, whereas a structure-independent rule may rely on arithmetic concepts such as 'first,' 'third' or 'last,' a structure-dependent rule relies on concepts such as 'main constituent,' 'subordinated constituent,' and so on.

Structure dependence is a relevant, non-trivial property of grammars; in fact, it is not a logical necessity, but rather a fact, about human language (Chomsky 1968:61, 1975:32, 1988:47, 59).[17] By any reasonable standards, structure-dependent rules are far more computationally complex – and, as such, more unlikely to be hypothesized by children – than structure-independent rules (Chomsky 1968:62, 1975:32). This is so because, on the one hand, the use of structure-dependent rules implicates a complex computational analysis of the structure of linguistic data, which requires the classification of elements into grammatical categories, the recognition of boundaries between such elements, the combination of these into abstract phrases, and the knowledge of the structural position that they have within their hierarchical disposition (Chomsky 1975:32, 1988:43; Tettamanti & Perani 2012:234).[18] This would require the language learner to have early access to *abstract* structural notions (Crain

[17] It should be noted that hierarchical structuring principles or structure-dependent operations are present at all levels of the structure of language (Chomsky 1968:63; Tettamanti & Perani 2012:230, 232); however, this work focuses on syntactic structure dependence only.

[18] As Chomsky (1975:32) points out, these phrases are 'abstract' in the sense that their boundaries or categorical classification (noun phrase, verb phrase, and so on) need not employ marks of any kind, neither in production nor in perception. In this manner, language is perceived as a "phonetic stream of words" (Crain & Nakayama 1987:522; Crain & Thornton 1998:166). It should also be considered that, even though structure dependence is present at all linguistic levels, only part of these hierarchical properties and relations are evident at the level of production and perception (Tettamanti & Perani 2012:232). What's more, "[m]ost hierarchical relations are established at a deep abstract level and are not obviously mirrored by surface structures, [which] poses intriguing questions about the mechanisms underlying language acquisition" (Tettamanti & Perani 2012:232).

& Thornton 1998:165; Tettamanti & Perani 2012:234).[19] On the other hand, the application of the computationally simpler structure-independent rules only requires the speaker to be able to identify the units which conform a sequence and their linear order (Chomsky 1988:43). Consider the following examples of yes-no question formation proposed by Chomsky (1975:30–31):[20]

(1) The man is tall.

(2) Is the man____tall?

Chomsky's proposed sentences (1–5; see below) are considered to be the type of most obvious examples of structure dependence in English Grammar. Example (1) is a simple declarative clause, while example (2) is its interrogative counterpart. In order to render an interrogative clause out of an initial declarative one, the verb from the main clause in example (1) needs to be moved to the front of the sentence, thus yielding Subject/Auxiliary inversion, as illustrated in (2) (Berwick et al. 2012:25; Chomsky 1988:43; Crain & Nakayama 1987:526–527). In simple cases like (1), a linear rule such as "Move the first verbal element to the front of the clause" would definitely produce a grammatical interrogative like the one in example (2). However, the same linear rule would fail utterly at generating grammatical results for complex cases such as (3), which is illustrated in (4):

(3) The man who is tall is in the room.

(4) *Is the man who____tall is in the room?

This is so because such a structure-independent rule would rely on 'counting' the occurrences of verb forms while ignoring their structural position, thus selecting the auxiliary verb from the *subordinate* clause for Subject/Auxiliary inversion, instead of the verb from the *main* clause. So, the only correct rule is the structure-dependent one, which contemplates the structure of its constituents, and not their order, as shown in (5) (Berwick et al. 2012:25):

(5) Is the man who is tall____in the room?

[19] Cf. section 1.2, p. 7, where it is stated that nativist models rely on the learner's innate knowledge of abstract principles.

[20] Yes-no question formation is the formulation of a closed interrogative clause (or yes-no question, or polar interrogative) out of an initial declarative one. In many of the interrogative examples proposed in this work, an underscore ( ) will be introduced to mark the structural position that the verb would have if it were not fronted, in order to better illustrate the workings of structure-dependent rules.

Contrary to what may seem logical, there is no *a priori* necessity for human grammars to use exclusively structure-dependent rules instead of structure-independent ones (Chomsky 1968:61–62, 1988:46). Codes which use the simpler linear rules – thus relying upon 'counting' operations – can be easily constructed (Berwick et al. 2012:26). Notwithstanding, any such code – no matter how complex, or how well it fulfilled the purposes of communication – would never be an instance of *human* language, because language invariably lacks 'counting' rules (Berwick et al. 2012:26; Chomsky 1968:62, 1988:46). Consequently, linguistic innateness hypothesizes that the LF is different in *kind* from other cognitive abilities (Smith 1999:133). Whereas other mental processes require 'counting' operations and pattern recognition, this approach at processing supposedly fails at explaining how language works, because "grammars can't count: rather, all linguistic operations are structure dependent" (Berwick et al. 2012:26; Smith 1999:133–134).[21] As a result, linguistic rules invariably consider structure-dependent operations, despite the fact that their production is merely sequential (Chomsky 1988:43, 45; Tettamanti & Perani 2012:231).

The powerful statements generated by the APS stream from the fact that both linear and structure-dependent rules are available for human mental processes, yet only structure-dependent rules apply to grammar (Chomsky 1975:32, 1988:48). Apparently, children make many mistakes during language acquisition, but never those which involve the use of structure-independent rules (Boeckx 2006:73; Chomsky 1975:31, 1980b:40). It seems that

[21] Evidence from Christopher, the polyglot *savant* who has been extensively documented over the years, supports such a claim (Smith 1999:24, 134). He is considered to be a paramount example of how linguistic competence and general intelligence dissociate (Smith 1999:24). Christopher, along with a control group of undergraduates, was charged with the task of learning a 'language' which contained several structure-independent rules (Smith 1999:134). Such rules would be impossible in any natural language and, therefore, they would also be incompatible with the allegedly innate principles of UG. Unsurprisingly, and despite his extraordinary capacities for second-language learning, Christopher proved unable to learn such structure-independent rules (Smith 1999:134). What is more striking is that neither did the control group, regardless of their greater intelligence (Smith 1999:134). Consequently, it was hypothesized that the structure-independent rules were so linguistically alien to the undergraduates that they could not use their general-intelligence mechanisms to apply them to language learning (Smith 1999:134). They could, however, identify and solve computational problems of equal complexity in cases which did not entail linguistic processing (Smith 1999:134). Chomsky (1988:46–47) had previously predicted this by stating that, compared to structure-dependent rules, and in spite of being computationally simpler, learning structure-independent rules would require much more effort from children. Supposedly, children rely on automatic computational operations housed in the LF to process structure-dependent rules (Chomsky 1988:47). However, for structure-independent rules, children would need to perform such linear operations consciously, which is more costly (Chomsky 1988:47).

infants select the computationally more complex structure-dependent rules invariably and without error at all stages of language learning, eschewing the equally available structure-independent rules – even though these could be compatible with the majority of their PLD (Boeckx 2006:71; Chomsky 1988:48; Crain & Nakayama 1987:522; Crain & Pietroski 2001:162–163). This fact is even more striking considering that, according to the third level of data deficiency from the APS, children have *no data* to make such an unerring choice in opting for structure dependence (Chomsky 1988:50; Lightfoot 1999:51). This is the kind of error-free learning that nativists have postulated when it comes to innate constraints (MacWhinney 2004:888). As a result, nativists have claimed structure dependence to be a property of the LF, i.e. an innate constraint contained by UG (Chomsky 1980b:40, 1988:48). In conclusion, the knowledge of structure dependence seems to be an *a priori* condition of language, since children never hypothesize structure-independent rules in the first place (Chomsky 1968:62, 1975:32, 1986:7–8, 1988:44–45; Crain & Nakayama 1987:522). The proposal that structure dependence is an innate principle of the LF or UG, which operates upon the child's judgment of the PLD and yields structure-dependent rules as the only candidates, has been subjected to empirical test (Chomsky 1975:32–33, 1988:44– 45). According to Crain & Pietroski (2001:162–163), every child that has been experimentally studied has adhered themselves to the structure-dependence hypothesis. These experiments and their corresponding results will now be presented.

3.2.2 Yes-no question formation: experiments and results

Crain & Nakayama (1987) carried out a series of experiments to test children's knowledge of structure dependence at several stages of language acquisition. For this purpose, the researchers designed a study which required children to engage in yes-no question formation; subsequently, they analyzed the kinds of hypotheses that children entertained for Subject/Auxiliary inversion. The reason for choosing this aspect of English Grammar is that, besides being a quintessential case of structure dependence, the formation of complex yes-

no questions in English is also thought of as the strongest case of stimulus *absence* (Pullum & Scholz 2002:36).[22]

In these experiments, the children's task was to apply their grammatical knowledge to the formation of a complex yes-no question out of a given declarative sentence, a task which they were likely to not have attempted before (Crain & Nakayama 1987:527). Most of the complex targeted sentences contained a subordinated clause modifying the Subject noun phrase, in the manner of Chomsky's example (5) (Chomsky 1975:31; Crain & Thornton 1998:165, 170). Additionally, most test sentences also contained one complex verb phrase in the subordinated clause – with one auxiliary and one main verb –, while the verb phrase in the main clause was simple. An example of the test sentences utilized in Crain & Nakayama's experiments (1987) is given in (6):

(6) The boy who is watching Mickey Mouse is happy.

To construct complex polar interrogatives, children would need to know that the verb from the main clause – and not the one from the subordinate clause – is the one that must be moved to the front of the sentence. This operation is shown in (7):

(7) Is the boy who is watching Mickey Mouse____happy?

Notwithstanding, it is of crucial importance to note once again that yes-no questions could also be subjected to structure-independent analyses in many cases; for, as we have seen, structure-independent hypothesis are compatible with most of children's PLD (Crain & Nakayama 1987:522, 524; Crain & Thornton 1998:167). This has been previously demonstrated in Chomsky's examples (1) and (2): to construct yes-no questions with simple clauses, a linear rule – which is arguably simpler in computational terms, and therefore more likely to be hypothesized by children – would indeed render grammatical results (Chomsky 1975:30, 1988:43; Crain & Nakayama 1987:526). Additionally, it should be noted that a high number of the test sentences in Crain & Nakayama's study (1987) used the same verb, i.e. the verb *to be*, in both verb phrases, as it is illustrated in example (6). Apparently, the fact that a part of both verb phrases were identical could potentially encourage children to confuse the two and use a linear rule to move the auxiliary verb from the subordinate clause to the front, instead of moving the main verb from the main clause. Such an error is shown in (8):

[22] Subject/Auxiliary inversion is used in English Grammar to mark interrogative sentence type, thus involving a purely syntactic issue (Pullum & Scholz 2002:38).

(8) *Is the boy who____watching Mickey Mouse is happy?

Surely, the structure-independent rule fails at producing complex yes-no questions in complex cases. Notions such as 'main clause,' 'subject' or 'subordinate clause' are necessary to carry out the correct analysis of the data and produce the correct hypothesis (i.e. a structure-dependent rule), which in turn generates grammatical yes-no questions in *all* cases (Crain & Nakayama 1987:525–526). According to the theory of UG, this is the kind of knowledge that is native to children, which is what Crain & Nakayama (1987) put to the test.

The thirty children who were tested in this study were aged 3 to 5 years old, an age range at which children have been observed to hypothesize wrong generalizations regarding grammatical rules (Crain & Nakayama 1987:527). Again, the formation of a complex yes-no question such as (7) is a task which children were likely to not have ever attempted before this experiment (Crain & Nakayama 1987:527). Since the structure-independent hypothesis is consistent with the subset of their PLD, if children lacked the structure-dependent constraint contained by UG, it would be expected that at least some of them might entertain structure-independent hypotheses in eliciting the required yes-no questions (Crain & Nakayama 1987:526; Crain & Thornton 1998:171). This, however, did not occur.

Even though children produced many ungrammatical constructions, thus hypothesizing the 'wrong' rules for their target grammar, none of these were errors which specifically implicated a structure-independent hypothesis (Crain & Nakayama 1987:530). In other words, it seems that all children abided by structure dependence, thus lending presumptive support to Chomsky's contention that children never consider structure-independent rules in the first place (Crain & Nakayama 1987:522, 530).[23] According to the theory of UG, children never entertain structure-independent hypotheses even if their PLD is in accordance with such rules (Crain & Nakayama 1987:527, 533). On the contrary: they attempt to form complex yes-no questions by invoking their allegedly innate knowledge of structure dependence, no matter how computationally complex in comparison with linear

[23] Moreover, the evidence from these experiments supports Chomsky's prediction concerning the autonomy of syntax with respect to semantics (Crain & Nakayama 1987:522, 542). Smith (1999:126–129) has also argued for the autonomy of syntax, in the light of Christopher's disassociated abilities as well as other pieces of evidence which also seem to support modularity and domain specificity. Correlations between structure dependence, modularity and domain specificity are also apparently supported by evidence from neurophysiological investigations of the brain (with special attention on Broca's area) explored in Tettamanti & Perani (2012).

rules (Crain & Nakayama 1987:527). As a result, the evidence gathered from these experiments corroborate that children's grammatical hypotheses seem to be highly constrained by the principle of structure dependence (Crain & Nakayama 1987:542; Crain & Thornton 1998:174).

Notwithstanding, it must be taken into account that evidence from these experiments are not conclusive, but merely *supportive*, of the claims of UG made by Chomsky; critical or decisive experiments remain to be reported (Crain & Nakayama 1987:524). In fact, Crain & Thornton (1998:172) emphasize the fact that Crain & Nakayama's study (1987) could only argue for a weaker claim concerning the innate knowledge of structure dependence, by relying on the fact that blatantly structure-independent rules were never tested by children. In this manner, it is assumed that because children did not in fact produce any yes-no questions that violated the structure-dependence constraint, such a constraint is indeed innate and in place in their grammars, especially taking into account the fact that many ungrammatical questions were elicited, and none were of them followed a linear hypothesis (Crain & Thornton 1998:175).

In conclusion, it is true that the formulation of structure dependence as an innate constraint would effectively solve the problem of the APS in all grammars, yielding a solution to the acquisition puzzle (Crain 1991:599; Lightfoot 1999:58). Nevertheless, as we have just seen, results from the yes-no question formation experiments did not indubitably attest for the innateness of structure dependence. In fact, many linguists have criticized nativists' use of the APS, as well as their formulation of UG and the consideration of structure dependence as one of its innate constraints. Such criticism will be explored in the following section (4).

4. Debate on structure dependence and the APS

In this section, I will offer a brief review of the current debate regarding the consideration of structure dependence as a quintessential case of the third data deficiency, which is the only decisive level of the APS. As we have seen in section 3, innateness hypothesis uses this argument to defend the thesis that structure dependence must be an innate constraint. In order to show the other side of the discussion, I will now present several critiques on nativist arguments applied to the case of structure dependence. Even though this issue has been addressed by many authors, due to space limitations I have made a short selection of the most relevant researchers in this matter. Firstly, these authors' conclusions will be presented, along with the implications that their findings have regarding nativists' claims of innate linguistic knowledge. Subsequently, I will contrast such findings with those of other scholars (Legate & Yang 2002) who have shown dissimilar results that support linguistic innateness.

4.1 Critiques on innateness hypothesis: a firm rejection of the third data deficiency

As we have seen in section 3, the APS maintains that structure dependence is 'underivable' from children's PLD (Chomsky 1988:47). Structure dependence is a typical example of the third data deficiency; this level of the APS is not based on stimulus poverty, but rather on stimulus *absence* (Pullum & Scholz 2002:16). Chomsky (1980c:114–115) has been extensively criticized for maintaining that children do not encounter direct evidence of structure-dependent rules; his claim is based on the assumption that complex cases in which the structure-dependent rule is the only possible hypothesis rarely arise. Following Chomsky (1980b:40),

> A person might go through much or all of his life without ever having been exposed to relevant evidence, but he will nevertheless unerringly employ [the structure-dependent hypothesis], never [the structure-independent hypothesis], on the first relevant occasion.

Hornstein & Lightfoot (1981:9) have also argued that there is total lack of evidence for some aspects of grammar, especially for knowledge of structure dependence. This is quite a strong

nativist claim which has been heavily refuted over the years.

As Sampson (1997:43) points out, Chomsky's arguments were theoretically-based statements which he never validated with data withdrawn from corpora or studies about language acquisition. Many authors believe this to be the biggest flaw in Chomsky's formulation of the APS (Pullum & Scholz 2002:45). After all, this argument – especially focusing on its third and decisive level – relies on the supposed *absence* of the stimulus for it to hold; thus, examining children's PLD to check whether this lack of evidence can be confirmed empirically seems strictly necessary (Pullum & Scholz 2002:21). The importance of Chomsky's lack of empirical corroboration is not to be underestimated, since it has thought to be enough of a reason to reject his premises until proven otherwise (Sampson 1997:43). In fact, authors such as Sampson (1997), Pullum & Scholz (2002) and MacWhinney (2004) have done exactly this: they have tentatively assumed that children do *not* lack information about the structure dependence of syntax. These scholars strongly discard the formulation of the APS, especially its third level of data deficiency. They suppose that the data are indeed rich enough for children to have clear evidence of structure-dependent rules, a thesis which they have attempted to demonstrate empirically (MacWhinney 2004:884; Pullum & Scholz 2002:11–17, 39–40; Sampson 1997:43).[24] After all, there *are* constructions in English Grammar for which structure-dependent rules are the only possible hypotheses; these could potentially be part of a child's PLD, and thus provide decisive evidence in choosing structure-dependent over structure-independent rules in grammar formation (Boeckx 2006:70).

This view, which challenges linguistic innateness hypothesis, is consistent with the position which Piaget originally assumed in relation to Chomsky. Despite the fact that both authors did agree on some important points regarding their conception of language and thought, Piaget (1980b:57) has made a strong critique of Chomsky's defense of innate linguistic knowledge, basing his criticism on biology and psychology. Piaget (1980a:23) defended the thesis that no *a priori* or innate cognitive structures exist in the human species. As the canonical representative of constructivism, Piaget has postulated that language learning is an exemplary case of learning by induction (1980a:23–24, 1980b:58–59). He has

[24] Although Pullum & Scholz (2002) do question nativist claims of innate knowledge of the structure-dependence constraint (among others), they clearly advise against reading their paper as an instance of anti-innateness. According to them, their research simply challenges nativist statements that, to their mind, have not been properly ascertained with data (Pullum & Scholz 2002:10).

stressed the active role that the language learner supposedly has during language acquisition; in the light of experience, and thanks to their growth and general cognitive schemes, children *construct* knowledge about their language (Piaget 1980a:23–25). These learning mechanisms are completely general and operative since the moment of birth, and ultimately rely on the richness of the stimulus (Piaget 1980a:24).[25] In this manner, although the child plays an active role in *constructing* their linguistic knowledge, only a PLD that is rich enough will provide the necessary inductive base for language acquisition. This is precisely what Sampson (1997), Pullum & Scholz (2002) and MacWhinney (2004) argue for in the case of structure dependence.

The authors mentioned above maintain that it is impossible for English speakers to not have encountered *any* relevant sentences for structure dependence during their lifespan (Pullum & Scholz 2002:41). Notwithstanding, adult's linguistic experience is unimportant to our case, because the question that we are concerned with is how children come to acquire knowledge about structure dependence; in this manner, the only relevant linguistic experience is that which is received during childhood. Although the ideal manner of testing the presence of direct evidence for structure dependence in children's PLD would be to record the *entire* PLD of at least one child, this task is currently unattainable for obvious reasons (Pullum & Scholz 2002:21). As a consequence, linguists have turned to corpora instead, under the assumption that a property which is supposedly absent – as nativists argue – from children's PLD will also be absent from any corpus that records child speech as well as speech addressed to children at the age of language acquisition (Pullum & Scholz 2002:21).

Pullum & Scholz (2002:41–42) have made a very interesting case by expanding the type of sentence that would offer direct evidence of structure dependence. Besides Chomsky's canonical example of polar interrogatives (1975:31) which have the same verb both within the main clause and the relative clause – as shown in example (5) –, Pullum & Scholz (2002:41–42) argue that any interrogative sentence which has an auxiliary verb within the Subject noun phrase also counts as crucial evidence for structure dependence. Therefore,

[25] The general learning mechanisms that Piaget (1980a:24) argues for do not imply any sort of knowledge on behalf of the organism, since they are purely inductive. Thus, Piaget's proposal differs greatly from a nativist one.

following Pullum & Scholz (2002:41–42), complex questions that take a modal verb (9) and complex *wh*-questions (10) with an auxiliary verb in the embedded relative clause clearly provide evidence for structure-dependent syntactic rules as well, a view which is also shared by MacWhinney (2004:10). Besides Chomsky's canonical example (5), following Pullum & Scholz (2002), these are the types of utterances that linguists should look for in children's corpora:

(9) Can the people who are talking leave now?

(10) Where did the women who were singing go?

Additionally, Sampson (1997:42) also extends this claim to sentences in which an auxiliary precedes the main clause auxiliary, such as (11):

(11) If you don't go tomorrow, can I stay with you?

Sampson's argument has been examined by Pullum & Scholz (2002:41–42), who have considered it to be a valid example. However, in (11), the auxiliary of the subordinate clause is not fronted, since the conditional if-clause is a declarative sentence, not an interrogative one. For this reason, I am reluctant to accept (11) as an adequate illustration of crucial evidence in favor of the structure-dependent auxiliary fronting hypothesis that we are concerned with.

With the purpose of proving that there is not absence of the stimulus in children's PLD, Pullum & Scholz (2002:42–43) searched various written sources, such as the *Wall Street Journal* corpus – henceforth *WSJ* – for structures of the type (5), (9) and (10). Apparently, the occurrence of such structures is fairly common, even if the search were limited to polar interrogatives only (Pullum & Scholz 2002:42–43). An example of a yes-no question found in the *WSJ* corpus provided by Pullum & Scholz (2002:42) is given in (12):

(12) Is a young processional who lives in a bachelor condo as much a part of the middle class as a family in the suburbs?

It must be taken into account that this polar interrogative does not fully resemble Chomsky's canonical example (5), as it does not have the same verb form (i.e. *is*) in both the subordinate and the main clause. Consequently, Pullum & Scholz (2002:43) also checked other sources, such as Oscar Wilde's play *The Importance of Being Earnest*, in which they did find a relevant example (13):

(13) Who is that young person whose hand my nephew Algernon is now

holding in what seems to me a peculiarly unnecessary manner?

Nevertheless, as MacWhinney (2004:89) points out, the fact that structures (12) and (13) are present in formal English texts does not necessarily mean that they will occur in children's PLD. As a consequence, both MacWhinney (2004) and Pullum & Scholz (2002) have furthered their research by employing data from the CHILDES corpus, one of the most important databases for child language. For this purpose, they analyzed input from files corresponding to English-speaking children (MacWhinney 2004:890). Their findings were, initially, quite surprising.

Pullum & Scholz (2002:44) focused their search on the utterances addressed to a child named Nina (aged 1;11 to 3;3) by consulting one of the files of the corpus of this particular child (CHILDES file NINA05.CHA). Apparently, Nina was indeed receiving relevant input concerning structure-dependent rules, since structures of the type (10) were fairly common in her PLD (Pullum & Scholz 2002:44). What's more, these authors claim to have found similar evidence in every child corpus that they have searched (Pullum & Scholz 2002:44). Considering the fact that approximately 30 percent of a child's PLD consists of questions, these authors suggested that it is likely that some of such questions are complex sentences with embedded relative clauses, although they admit that most of them do not take the crucial form (5) (Pullum & Scholz 2002:44–45). All in all, Pullum & Scholz (2002) present their results as solid evidence for the rejection of the APS.

However, Pullum & Scholz (2002) do not provide the necessary percentages to contrast the number of critical evidence for structure dependence with the number of total sentences (Legate & Yang 2002:157). And neither does MacWhinney (2004), who reaches similar results as Pullum & Scholz's (2002). In fact, MacWhinney (2004:890) merely states that there are hundreds of evidence for *wh*-questions with embedded relative clauses in the CHILDES corpus, without providing the corresponding percentages. So, in principle, it seems that children have access to an unspecified number of sentences of the types (9) and (10); according to MacWhinney (2004) and Pullum & Scholz (2002), this would suffice to conclude that the APS is invalid.

Interestingly, the supposed high number for types (9) and (10) does not match the occurrences of type (5). In fact, MacWhinney (2004:890) has found that the occurrence for an utterance with the structure found in (5) corresponds to one case out of an approximate

number of 3 million utterances in the CHILDES database. Consequently, MacWhinney (2004:890) does not hesitate at concluding that positive evidence for this particular structure – Chomsky's canonical example, and Crain & Nakayama's (1987) targeted structure – is seldom encountered by children under 5 years of age.

Notwithstanding, Pullum & Scholz's research (2002:45) suggests that the percentage of relevant data for structure dependence would make up at least 1 percent of all the interrogative clause types in any average corpus, by extending the claim of relevant data to types (9) and (10). Pullum & Scholz (2002:45) also point out that defenders of the APS have yet to determine what percentage of relevant cases must be reached for structure dependence to be learned by children. As a consequence, the question of whether the 1 percent magnitude proposed by them is enough for learnability of structure dependence remains open (Pullum & Scholz 2002:45). There is, at any case, a strong rejection of the APS on behalf of Pullum & Scholz (2002) and MacWhinney (2004); such a rejection has been criticized, in turn, by linguistic innateness supporters.

4.2 Possible confirmation of the third data deficiency

Contrary to Pullum & Scholz's position, Legate & Yang (2002:151) maintain that Pullum & Scholz (2002) had failed at demonstrating the sufficiency of the relevant evidence, which they, in turn, consider to be ultimately deficient. To their mind, both the APS and the claim of innate linguistic knowledge remain unchallenged (Legate & Yang 2002:151).

By looking into the CHILDES corpus, Legate & Yang (2002:155) also reach Pullum & Scholz's (2002) initially surprising conclusion: that critical evidence for structure dependence does exist in children's PLD. However, they heavily criticize Pullum & Scholz's (2002) decision to analyze only *one* child and only *one* file; curiously, the selected file (NINA05.CHA) has the highest number of critical sentences out of the 56 files that the CHILDES corpus has for that child, Nina (Legate & Yang 2002:157). Additionally, they also argue that even if a child's PLD does contain some occurrences of decisive evidence regarding structure dependence, this fact need not mean that such evidence is enough to impact the child's linguistic development, or that it guarantees that it will be present in every child's PLD (Boeckx 2006:72; Legate & Yang 2002:155–157). And, as Pullum & Scholz

(2002:45) and Boeckx (2006:72) forewarn, a certain percentage of occurrences is necessary for the data to be *learnable*.

In their paper, Legate & Yang (2002:155–157) discuss the percentage of occurrences that a certain aspect of language needs to have in children's PLD for such data to impact their development; these calculations were based on how and at what age the average child acquires a certain feature. The issue goes as follows: children do not seem to hypothesize structure-independent errors in the first place. This is compatible with two scenarios: either (a) structure dependence is innately known by children, or (b) there is sufficient evidence that teaches children about structure dependence so that they do not get the chance to hypothesize structure-independent rules, because they learn about structure dependence. But since there is so little evidence of structure dependence in children's corpora, in order to present a minimum learnability percentage, Legate & Yang (2002:155–157) provide the necessary statistics by counting the evidence for *other* aspects of grammar which children showed to have attained at a comparable age at which they also showed abidance to structure dependence (ca. 36 months). Taking all the positive and negative data available to children which is recorded in the CHILDES corpus for those aspects, they compared the percentage that such utterances represent with the total number of utterances to which children had been exposed up to that time.[26] Legate & Yang (2002:154, 157) concluded that the necessary frequency of crucial evidence for the child to rule out the structure-independent hypothesis (assuming, for the sake of argument, that the choice of possible hypotheses were binary) would be of 1.2 percent of the total PLD. This percentage would be the *minimal* magnitude.

Legate & Yang searched the 56 files dedicated to the child named Nina in the CHILDES corpus. Out of a total of 46,499 sentences, 20,651 were questions; none of such questions were complex polar interrogatives of type (5), while fourteen of them were complex *wh*-questions like (10) (Legate & Yang 2002:157). This makes up a total of 0.068

[26] Following a biological conception of language acquisition, it could be possible to criticize Legate & Yang's (2002) criteria for such calculations. According to Crain, "[l]ike aspects of physical development of the body (e.g., the secondary sex characteristics), linguistic principles may lie dormant for many years, biologically timed to become effective at a certain maturational stage" (1991:600). The moment of acquisition of a particular feature, then, would not necessarily imply that such a feature did not appear before because the child had not been presented with enough data yet, as Legate & Yang (2002:157) seem to suggest. On the contrary: if certain linguistic principles were innate, maturation – rather than measured or timed exposure to relevant data – would be the ultimate determinant factor.

percent of critical evidence recorded for this particular child, which is 40 times lower than the estimated 1.2 percent magnitude (Legate & Yang 2002:158). Their findings for Nina were also contrasted with the statistics from another child, named Adam; in Adam's corpus, they found an ever lower frequency: only 0.045 percent of his recorded PLD represented relevant data for structure dependence (Legate & Yang 2002:158). Interestingly, the canonical type of critical evidence (5) – and Chomsky's preferred example – does not appear even once in the 66,871 recorded sentences that make up the Nina and Adam corpora (Legate & Yang 2002:159).

In conclusion, the very low number of occurrences of decisive structure-dependent constructions is of a considerably lower magnitude than it is required for learnability (Boeckx 2006:72; Legate & Yang 2002:158). In other words, constructions in which structure-*independent* rules are perfectly compatible with the data make up the majority of these two children's linguistic experience (Boeckx 2006:70; Legate & Yang 2002:158). In the light of this evidence, nativists are tempted to consider the relevant data as negligible, i.e. not reliably available for all children; yet it is known fact that all normal children acquire structure-dependent rules (Boeckx 2006:72–73; Legate & Yang 2002:158). Given the percentage of relevant occurrences, if Legate & Yang's learnability claims concerning the minimal percentages were to hold, the APS would be indisputable (Boeckx 2006:71). It is in this vein that they assume structure dependence to be an innate aspect of syntax that is "available to children in the absence of experience" (Legate & Yang 2002:159).

The claim of innateness, however, is a very problematic and controversial one. Mainstream Generative Grammar has argued for the innate nature of linguistic features by conflating the terms 'innate' and 'genetic,' thus endowing genes with a sort of special power in determining innate characteristics of the organism. However, this conflation is not accepted by developmental biology, for genetic determination is not a condition *sine qua non* for innateness. What's more, recent developments within the field of developmental biology have shed light on the contemporary debate concerning linguistic innateness, defending the view that the conflation between the innate and the genetic levels is incorrect. Such a strong claim, which has far-reaching consequences for the rationale behind the APS, will be explored in the following section (5).

5. Innateness revised: a critique on linguistic innateness hypothesis based on developmental biology

In this section, I will offer a brief critique on the notion of 'innateness' that the theory of linguistic innateness relies on. As we have seen in sections 2 and 3, this theory defends the thesis that some linguistic information is innate, while also equating 'innate' with 'genetically determined.' According to the premises of developmental biology, this idea – i.e. that something is innate only if it is present in the genetic material of the organism – is false. With the purpose of showing a more *biologically* realistic revision of linguistic innateness, I will provide a selection of arguments from the field of developmental biology which demonstrate that the aforementioned conflation is nothing but a fallacy.

5.1 The rationale behind the APS

As we have already seen, the APS is a crucial and central argument from which the formulation of linguistic innateness is derived. Briefly put, the workings of the APS go as follows:

1. Speakers have knowledge of an aspect X of language (e.g. structure dependence).
2. X could not be derived from the linguistic input.
3. If X could not be derived from the linguistic input, it was not learned.
4. If X was not learned, then it must be innate.
5. Since X is innate, it must be contained or pre-specified by the genes of the speaker (UG).[27]

[27] As Smith clearly puts it, linguistic innateness supporters such as himself defend the view that properties such as structure dependence "have become encoded in the genes of the children" (1999:173).

As we have seen in section 4, the nativist conclusion which is derived from premises 1–4 is reasonable, since it is arguable that there is not sufficient evidence for the learnability of structure dependence in the linguistic input. However, according to developmental biology, the content of premise 5 is false. The reasons for such a statement will be explored in the following section (5.2).

5.2 The (indirect) relationship between genes and traits

To put it simply, premise 5 comes to state that a phenotypic trait is innate if its existence is determined by genetic factors (Mameli & Bateson 2006:158; Samuels 2004:137).[28] This perspective, which was adopted by linguistic innateness hypothesis, was initially defended by one early 20th century framework within the field of biology known as Neo-Darwinism. This was an extremely genocentric trend which attributed the central role as causal agents to genes when it came to explaining innateness (Longa & Lorenzo 2012:56). As Longa & Lorenzo (2012:55) indicate,

> [G]enes were given priority over other developmental levels and resources, in such a way that they were considered the only possessors of the essential information guiding the growth and maturation of organic studies.

From the 1960s onwards, molecular Neo-Darwinism came to argue for the existence of genetic programs or blueprints contained by the genes of the organism, thus explaining the relationship between genotype and phenotype in terms of plan and product while also reinforcing the primacy of the genetic level (Jablonka & Lamb 2005:33). In this manner, the development of the organism would merely consists on the unfolding of the information already contained in the genes (Longa & Lorenzo 2012:56). This genocentric perspective, which is highly problematic, is currently being challenged by a reacting framework known as developmental biology (Longa & Lorenzo 2012:57, 63).[29] The developmental framework rejects genocentric premises, since genocentrism "ignores the contribution of many factors

[28] Cf. section 3.2, p. 22 for a brief definition of genome, genotype and phenotype. The distinction between genotype and phenotype is crucial in genetics (Jablonka & Lamb 2005:28).
[29] In fact, Oyama et al. (2001:5) affirm that there is no scientific evidence that proves the existence of genetic programs.

and resources located between genes and traits, without which development would not take place" (Longa & Lorenzo 2012:58).

According to Neo-Darwinism, genes are hereditary units which carry information about the organism's traits (Jablonka & Lamb 2005:24–29). In order to defend the view that genes contain information about specific traits, Neo-Darwinian biologists follow one of two possible approaches: either a 'causal' or a 'representational' account of genetic information (Samuels 2004:137–138). Both the causal and representational accounts deal with how the genetic information contained by the genes is supposedly accountable for the development of specific traits. With the purpose of introducing critiques from a developmental perspective, the two approaches that were traditionally adopted to defend the traditional notion of innateness will be presented.

Firstly, the representational approach maintains that "traits are genetically determined if represented in (or encoded by) the genes" (Samuels 2004:137). This statement somehow implies that traits are pre-specified in the information encoded by genes. However, it has been noted throughout the years that the only information that genes or DNA sequences directly contain is the information which is involved in the production of proteins (Godfrey-Smith 2007:110; Jablonka & Lamb 2005:30; Longa & Lorenzo 2012:60; Mameli & Bateson 2006:159; Samuels 2004:138). Evidently, the claim that genes contain information about the phenotype is also accepted, but with certain limitations that must be taken into account. According to Godfrey-Smith (2007:106),

> [W]e can say that genes contain information about the proteins they make, and also that genes contain information about the whole-organism phenotype. But when we say that, we are saying no more than what we are saying when we say that there is an informational connection between smoke and fire, or between tree rings and a tree's age.

So, the notion of innateness defended by Neo-Darwinism claims that genes can represent the traits of the phenotype directly; according to developmental biology, "no such notion of [genetic] representation appears to exist" (Samuels 2004:138). As Wimsatt maintains, "[e]quating 'innate' with 'genetic' is a kind of functional localization fallacy," which wrongly implies "assuming that the function of a larger system or subsystem is realized completely in a part of that system" (1999:160). Since the only genetic information directly contained by genes is that of constructing proteins, identifying innateness with the coding of the phenotype is plainly incorrect (Mameli & Bateson 2006:159). In other words, genes are

not *part* of the phenotype – at least directly – nor *representations* of it (Jablonka & Lamb 2005:28).

Secondly, the causal account of innateness according to a Neo-Darwinist perspective maintains that "traits are genetically determined if caused (in the appropriate way) by genetic factors" (Samuels 2004:137). In this manner, a trait is hypothetically innate if it is caused entirely by genetic factors, so that the only thing required for its development are genes (Mameli & Bateson 2006:158; Samuels 2004:138). However, these claims are inaccurate. To begin with, there is no clear explanation as to what the 'appropriate' relation between genes and innate traits is (Samuels 2004:137). And most importantly, there is no such phenotypic trait for which only genes are needed for its development (Mameli & Bateson 2006:158). In other words, traits are not caused by genes *alone*: they also depend on non-genetic sources for the development of the phenotype (Jablonka & Lamb 2005:28; Mameli & Bateson 2006:158; Samuels 2004:138). Therefore, genetic information and innateness cannot be equated, because the genetic level is just one of the many biological levels that intervene in a given organism's development.

To prove this point, Johnston & Edwards (2002) designed a model of behavioral development constituted by 13 levels of interacting factors, only *one* of which corresponds to genetic activity.[30] A list of the proposed factors goes as follows (Johnston & Edwards 2002:28):

1. Sensory Stimulation
2. Patterned Neural Activity
3. Neural Connectivity
4. Neural Growth
5. Non-neural Structures
6. Non-neural Growth
7. Individual Nerve Cell Activity
8. Extracellular Biochemistry
9. Cell Membrane
10. Intracellular Biochemistry

[30] In spite of being fairly recent, this model (Johnston & Edwards 2002) has already become a classic in its field.

11. Protein Synthesis
12. Physical Influences
13. Genetic Activity

It is stated that *all* biological levels, not just the genetic one, are needed for development, because "every trait is produced by the interaction of many developmental resources" (Oyama et al. 2001:2). So, while it is true that genes do influence the phenotype, they are not the only factor involved in development (Johnston & Edwards 2002:26). Furthermore, the route between genotype and phenotype is complex, and the effects of genes on the phenotype are very indirect because, among other reasons, the immediate consequences of genetic activity are confined to the cell (Johnston & Edwards 2002:28; Longa & Lorenzo 2012:64). Consequently, without appropriate environmental context, genes make nothing happen (Johnston & Edwards 2002:26; Longa & Lorenzo 2012:60). In fact, "the bare genes in isolation are among the most impotent and useless materials imaginable" (West-Eberhard 2003:93).

Finally, it should be noted that findings within the field of developmental biology do not undermine the notion of 'innateness' at all; they simply argue for a different formulation of 'innateness.' According to developmental biology, innate traits are simply those "that reliably appear at certain points of a species-typical path of development" (Longa & Lorenzo 2012:65). Thus, the thesis that innate traits exist is still defended; these, however, do not need to be genetically determined to be considered innate. In this manner, it is not the logical argumentation of the APS what developmental biology challenges; in fact, premises 1–4 are accepted. Notwithstanding, this is not the case with premise 5, since this step equates 'innate' with 'genetically determined,' which is not biologically accurate according to the developmental framework.

In conclusion, the result of development cannot simply be reduced to genetic activity because many equally important non-genetic factors are involved in this process (Longa & Lorenzo 2012:53, 58–60). This ultimately means that an innate trait need not be present in the genes of the organism, because (i) genes do not contain traits or programs, and (ii) genes are not the only causal agents of development (Godfrey-Smith 2007:114; Longa & Lorenzo 2012:53, 58, 65; Samuels 2004:137–138). Moreover, there is non-genetic inheritance, which means that genes are not the only recipients of hereditary information; consequently,

correlating ‘genetic’ with ‘innate’ is plainly false (Jablonka & Lamb 2005:32; Longa & Lorenzo 2012:63). For these reasons, it is evident that linguistic innateness hypothesis and the theory of innateness in general requires greater biological credibility, since its claim for genetic innateness has been dismantled by developmental biology. Moreover, I agree with those who encourage linguistic innateness theory supporters to avoid “the temptation to attribute magical powers to the genes” in arguing for the innateness of language (Johnston 1987:175).

Conclusion

The study of structure dependence has generated a significant body of non-trivial linguistic knowledge about the syntax of the English language, which has allowed linguists to make tentative assumptions about what the source of linguistic knowledge may be. Both positions in this debate – i.e. arguing for innateness, as well as arguing against it – are still provisional. As it has been extensively shown, there is not yet sufficient evidence to conclude the argument. Admittedly, up-to-date controversial issues such as the claim of innateness and universality of structure dependence are yet to be fully attested. Consequently, it seems evident that additional research on this topic is needed.

However, even though conclusive results remain to be reported, what has been achieved up to this point is not to be underestimated. The literature that has been created thus far conforms a secure base which will prompt future lines of research concerning structure dependence, English Grammar and Universal Grammar. In this respect, serious consideration of the criticism on the notion of 'innateness' offered by developmental biology could prove to be very useful in helping the theory of linguistic innateness progress realistically and in biologically accurate ways. In addition, we have also considered several authors' critiques concerning linguistic innateness' lack of empirical corroboration. Such criticism could also provide an appropriate base for progress and change within the theory of linguistic innateness, encouraging its development towards a linguistic theory which sought systematic empirical confirmation of its theoretical predictions.

Finally, it is evident that the study and analysis of structure dependence is a crucial piece of evidence in the acquisition puzzle that will allow researchers to answer the question of whether some aspects of language are innate or not. Thus, the study of English syntax from a formal perspective continues to be of interest within the field of linguistics in general, as well as within the theory of linguistic innateness in particular. As I intend on furthering my studies on linguistics, it is possible that I will consider tackling this line of research in the future. However, for the time being, my only hope is that this work will be recognized as a

humble attempt at producing a worthy bibliographical revision on the topic of structure dependence, English Grammar and Universal Grammar.

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