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Formal Linguistic Approaches to Adult Second Language (L2) Acquisition and Processing

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Abstract

This chapter provides an overview of the major contemporary trends driving adult, non-native language acquisition and processing research from a formal linguistic theory perspective. In doing so, we contextualize for the reader what formal linguistics is, inclusive of the main tenets of generative grammar. We provide an overview of the formative questions of generative second language acquisition (GenSLA), focusing on how they have been recast/refocused over time in accord with: (a) the evolution of formal linguistic theory, (b) insights from GenSLA's own research over three decades and other paradigms of SLA, as well as (c) the expansion of empirical testing methods to include psycholinguistic and neurolinguistic processing measures. All of the aforementioned is done with the backdrop of adult language learning in mind; that is, what do formal linguistic studies on adult non-native language acquisition and processing contribute to our understanding of how L2ers typically learn/process language?

1. Introduction

The relative conformity with which (typically developing) children attain adult grammatical competence—ultimate attainment—and the similarity in developmental paths along which they progress is remarkable (e.g., Ambridge & Lieven, 2011; Clark, 2003; Guasti, 2002; Synder, 2007). This achievement is, however, so ubiquitous and mundane that we seldom marvel at it Of course, monolingual adult grammars may also differ from one another, especially for some domains of grammar (e.g., Dąbrowska, 1997, 2012), but such variability pales in comparison to the variation in adult non-native second language (L2) grammars. Indeed, the path and outcomes of L2 acquisition can be highly variable from one individual to another, even under seemingly comparable contexts. Individual and group-level factors in adulthood that either do not apply or apply with much less consequence in young childhood conspire to explain at least some of the gamut of L2 variability.

Adults are less likely to be exposed to high/sufficient quantities and qualities of (native) input, which provide the indispensable raw material for specific grammar building (e.g., Carroll, 2001; Rankin & Unsworth, 2016; Rothman & Guijarro Fuentes, 2010). It is possible that adults do not maintain the same linguistic and/or cognitive abilities to acquire (e.g., Bley-Vroman, 1990, 2009; DeKeyser, 2000; Hawkins & Casillas, 2008; Long, 2005; Tsimpli & Dimitrakopoulou, 2007) and/or process language (Clahsen & Felser, 2006, 2017; Grüter & Rhode, 2013; Grüter, Rhode & Schafer, 2016) as children have. Whether or not the underlying mechanisms for language acquisition and processing are one and the same across the lifespan, one should expect factors such as motivation, influence from the L1, cognitive differences (e.g., working memory), context of learning (classroom versus naturalistic immersion) and linguistic aptitude, among other variables, to contribute to the range of individual differences in adult L2

path and ultimate attainment (e.g., Dörnyei, 1998, 2003, 2014; Linck et al., 2014; Rankin, 2016; Robinson, 2001, 2005, 2013; Schwartz & Sprouse, 1996; White, 2003).

We are all increasingly mindful of the inherent comparative fallacy implicated in most—but not all—monolingual to bilingual comparisons (e.g., Bley-Vroman, 1983; Ortega, 2013, 2016; Rothman & Iverson, 2010). It would, however, be inaccurate to pretend, even with contemporary calls to examine bilingualism in its own right, that the study of adult L2 acquisition is not motivated in large part by the goal of understanding what underlies typical L1 → L2 differences. No one denies that we need to understand the constitution of adult L2 grammars as the independent entities they are and in more ecologically valid terms, but doing so completely devoid of the traditional comparison goes beyond simply abnegating the past research agendas that paved the way to modern second language acquisition (SLA) studies. Most calls for the bilingual turn in SLA challenging the monolingual as a golden standard benchmark also recognize the intense curiosity one has to understand L1 versus L2 differences, and the value of understanding this further. Such calls remind us, above all, that we are comparing various types of apples to each other, if not apples to oranges. Sometimes it is quite useful, if not necessary, to compare apples to oranges, as long as we are aware weare doing so. Thus, L1 to L2 comparisons are not dead nor should they be. Alternatively, we need to be cautious of what we claim from L1-L2 difference comparisons and ask ourselves, juxtaposed against specific questions, if such a comparison is necessary and/or particularly insightful. We will be mindful of this discussion throughout this chapter, however, we will also be faithful to what has been done in the field within its proper (temporal) context, highlighting where some questions have been modified over time as advances in theory and otherwise shifting views have necessitated.

Forty plus years into the modern study of adult SLA, various paradigms of linguistic inquiry (e.g., generative grammar, construction grammar, lexical functional grammar, cognitive grammar, etc.) have been adopted as a backdrop against which subfields of SLA have emerged to frame and research adult non-native language acquisition and processing. The goal of the present chapter is to focus on one such approach; that is, generative approaches to SLA (GenSLA). GenSLA research has always been focused on describing and explaining the implicit knowledge of L2 representations in the mind/brain of the learner (see Rothman & Slabakova, 2017; White, 2018, for recent state-of-the-science reviews). The role that Universal Grammar (UG) may continue to play—in part or in whole—in restricting the hypothesis space for L2 grammatical learning—distinguishing between knowledge that is clearly acquired on the basis of exposure to L2 input and that which is more reflective of universal linguistic principles—has featured prominently in GenSLA for the entirety of the field's tradition, starting in the early 1980s. By the late 1990s, as we will see, GenSLA had expanded considerably beyond the focus on whether or not there was UG-accessibility after puberty. Indeed, GenSLA applies the tenets of formal generative linguistic theory (e.g., Chomsky, 1965, 1981, 1995) to guide the questions asked, make predictions about L2 linguistic behavior along the developmental continuum, inspire/define the selection of domains of grammar to empirically focus on, interpret the data and from them hypothesize about the constitution of non-native mental linguistic competence (i.e., I-language). In the remainder of this chapter, we contextualize what is meant by formal linguistics (past and present) as applied to non-native language studies, address what makes GenSLA different from other theories of SLA, and briefly review the history of GenSLA over the past three plus decades, with special consideration of how it has expanded since the early 2000s to include work on non-native processing using psycholinguistic and neurolinguistic methodologies.

2. The Main Tenets of Generative Linguistic Theory

Universal Grammar (UG) is claimed to provide a biological blueprint of sorts for efficient and constrained language learning, at least in children. Indeed, over the past two decades in particular there has been much discussion among generative theorists as to what precisely the innate language faculty offers. To be sure, discussion, debate and change at the level of formal theory has inevitable consequences for evolution of and application in GenSLA theory; however, this is of less consequence than one might think. GenSLA—like all approaches to SLA—is an empirical field that generates tried and true data of its own. Data collected with sound methodology exist (somewhat) orthogonally to any specific theory used to try to explain them. As formal theories get modified on the basis of advancements that run in parallel to, or as a result of, applying generative theory to (non-native) language acquisition, GenSLA's database stands the test of time, able to adjust to any then-current theory and/or serve as evidence to support it or reject it *a priori* (see also Schwartz & Sprouse, 2000). This said, the formation of theories, hypotheses, predictions, constructs, interpretations and more within GenSLA finds its roots within particular instantiations of then-current generative linguistic theory. And so, in a handbook chapter such as this it is useful to cursorily outline its main tenets as well as a few, specific versions of generative theory along the past decades in which GenSLA has existed in parallel.

Perhaps the most well-known theory that GenSLA has drawn from is the Principles and Parameters (P&P) approach from the days of Government and Binding theory (Chomsky, 1981). UG was argued to provide a blueprint of constraints, known as *principles* and *parameters*. *Principles* are constraints on the form any potential human language can take for a given domain. *Parameters* are, essentially, principles with choices: a universal property that reflects limited variation in the world's languages. For example, in all languages a sentence must minimally have a subject and a verbal predicate (with optional object arguments depending on the verbal argument structure): SV(O). All verbs in context have an intended subject, whether expressed phonetically or not. This principle—a truism of grammar—was captured under the *Extended Projection Principle (EPP)* (Chomsky, 1982). To the extent that the EPP is a proper universal principle, all utterances with a verb in all languages must always respect it. For example, sentences like *Robert thinks that __ like dogs more than cats* is ungrammatical because it violates the EPP. The verb 'like' in English is left without a specified subject that cannot be recovered alternatively, and so the universal rule that all verbs have a reliably interpretable subject is violated. As it turns out, not all subjects are overtly expressed, even in English, and so absence of an overt subject does not necessarily mean the EPP is violated. For example in control structures like *I want to go to the movies:* [I$_i$ want [$_{CP}$PRO$_i$ to go to the movies]], the EPP is satisfied by accessing the features of the higher subject, in other words, "I" serves as the subject of the matrix verb as well as the antecedent for co-reference of the empty category subject (PRO) of the embedded verb. Equally with coordinated clause structures, as in *I live in the UK and ___ teach at the University of Reading,* the syntactic structure is such that the EPP is fulfilled by the presence of the first expressed pronoun "I", accessible via coordination.

With the few exceptions above, it is fair to say that English-type languages require overt pronouns to always be pronounced. This is clearly not true of all languages in the world. For languages like Spanish, Turkish, Arabic and Korean, most subject pronoun positions in relation to verbs are phonetically unrealized. How could such languages exist if the EPP is truly a principle of grammar? The EPP merely states that all verbs have a readily accessible subject for interpretation; it does not stipulate how languages can vary in how this requirement is fulfilled. A related principle of grammar that provides a limited amount of choices for specific grammars to select is known as the Null-Subject Parameter (NSP). Whereas English is negatively valued for the NSP, thus requiring overt subjects ubiquitously, Spanish-type

languages are positively valued and thus make use of other linguistic means to fulfill the EPP requirement. Consider (1) and (2) in Spanish and (3) and (4) in Turkish below:

(1) Yo cre**o** que aquí nosotros vivi**mos** bien.
I believe-1PS that here we pro live-1PP well.
'I believe that we live well here.'

(2) __Cre**o** que aquí ___come**mos** bien.
pro   believe-1PS   that   here   pro   live-1PP   well.
'I believe that we eat well here.'

(3) Ben inanıyoru**m** ki biz burada iyi yaşıyoru**z**.
I believe-1PS that we here well live-1PL
'I believe that we live well here.'

(4) __ İnanıyoru**m** ki __ burada iyi yaşıyoru**z**.
pro believe-1PS that pro here well live-1PL
'I believe that we eat well here.'

In (1) and (3), the EPP is fulfilled ostensibly in the same way as in English—or in principle can be—via the use of overt pronouns in the canonical subject positions. In (2) and (4), the subjects are phonetically null (in main and embedded clauses alike), but the EPP is satisfied by the verbal morphology (in bold), which uniquely specifies the person and number of the only understandable subject, an impossibility in English given its weak verbal morphology. And so, while it can be said that all languages respect the EPP as a universal principle, parametric variation is captured under the NSP relating to how the EPP can be satisfied in various languages.

With the advent of Minimalism (Chomsky 1995, 2001), the proliferation of parameters and thus their very ecological validity was questioned. Over the years, the list of proposed principles and parameters (P&P) had grown into the hundreds, reasonably making one wonder how the mind could encode so much information at a zero state and indeed why it would do so in the first place. Minimalism, as the name would suggest, called for a more streamlined, elegant approach to describing the same facts of language that P&P uncovered and explained so nicely. It was argued that properties previously formalized under so-called principles and parameters were likely not specific mental constraints themselves, but rather consequences of core grammatical operations where functional features encoded on lexical items (including morphology) fulfilled their remit. And so, the EPP above was reduced to an AGREE(ment) operation, for example, between features associated with the subject position (Spec IP/TP) and the feature carried in languages like Spanish and Turkish on person and number morphology. The details are quite abstract, and their specificity is not really relevant to our purposes here. What is important, however, is the acknowledgement within Minimalism that a more reductionist approach was needed, but crucially one that could provide the same level of descriptive adequacy that decades of generative work had achieved. Indeed, as Ellis (1998) stated, 'it is the assumptions of UG that are under attack [by connectionist and other competing cognitive approaches], not the generative grammar descriptions of the relations between the linguistic units' (p. 633). We respectfully disagree with his underlying reasoning and, like Bruhn de Garavito (2011), we would point out that the 'generative grammar descriptions of the relations between linguistic units' that Ellis concedes are not problematic are in fact, often although not always, incompatible with theories that rely (virtually) solely on input and domain-general cognition. Nonetheless, it is prudent to point out that descriptions within

generative theory at the level Ellis (1998:633) refers to are regarded even by competing theories as at least descriptively accurate, and as a result must be accounted for by all iterations of theory, generative and otherwise.

The minimalist framework sets out to explain three basic properties claimed to be specific to human language syntax: (i) human language syntax is non-linear (except in production and parsing, including morphology and phonology/phonetics) as compared to non-human primates; (ii) hierarchical structure affects meaning and interpretation; and (iii) hierarchical structure is seemingly infinite (i.e., recursive) (Berwick & Chomsky, 2017; Fitch, Hauser & Chomsky, 2005; Fitch & Hauser, 2004; Hauser, Chomsky & Fitch, 2002). It was proposed that these three properties together comprised the fewest explanatory, but necessary, variables of language and, therefore, the best candidate for a single operation for the building of syntactic structures, which later became formalized as MERGE (Chomsky, 2001). Merge, simplistically speaking, is responsible for forming and hierarchically ordering syntactic objects (i.e., sets). In this respect, UG then accounts for the Basic Property of Language (BLP)—very simply put—because it is proposed to be an internal computational system responsible for the hierarchical building of human language syntactic sets (i.e., Merge) that interfaces with both external components such as production (phonology/phonetics), parsing, and morphology (word building), as well as conceptual systems (i.e., cognition) for appropriate inference making and interpretation.

Whatever UG's actual composition turns out to be, its main functions will always be a gap-filler and an accelerator, providing an answer to how language can be acquired so effortlessly and rapidly despite the complexity of the task and in light of seemingly incomplete input. UG must also be the proverbial agent that reduces the hypothesis space the mind considers from all logical possibilities to those that are compositionally and computationally parsimonious with natural human language—why children make only a subset of all reasonably possible errors. Whether this turns out to be (a) a truly minimal set of core mental operations specific to language such as MERGE, (b) an inventory of formal (functional) features of grammar, or (c) more akin to an actual blueprint of principles of universal linguistic well-formedness with room for language specific (parametric) variation, the general abstraction of UG remains the same: UG will be the smallest amount of innate structure needed to explain outcome competence that ultimately cannot be reduced to deduction from the input and domain-general cognition alone.

3. What makes GenSLA different (and not so different) from other SLA approaches?

All SLA theories that focus on language as a cognitive phenomenon—as opposed to those in which learner-external factors take center stage—are broadly concerned with describing the process by which child and adult non-native learners come to produce and understand utterances in the L2, to variable degrees of communicative efficiency and native-likeness. In an argument that very much parallels debates in first language acquisition (FLA), the fundamental difference between GenSLA and other approaches is the extent to which the different theories consider some L2 knowledge to be acquirable solely from an interaction between the available input and domain-general cognitive systems. To be sure, any GenSLA scholar would agree that meaningful input and domain-general mechanisms are fundamental ingredients of L2 acquisition. The increasingly central position that input quantity and quality is assuming in generative SLA studies in recent times (see, e.g., Rankin & Unsworth, 2016; Slabakova, 2013; Yang & Montrul, 2017) represents perhaps the largest area of crossover between GenSLA and so-called data-driven approaches (see Rothman & Slabakova, 2017, for

a detailed discussion of what generative and usage-based paradigms share beyond their differences in focus).

Notwithstanding the above, a significant part of the knowledge that a typical L2 learner acquires poses a problem for theories that do not contemplate the involvement of domain-specific machinery. In the 1980s, a few scholars (e.g., Bley-Vroman, 1989; White, 1985) began considering the question of whether one could indeed speak of a *logical problem of second language acquisition*, very much in the same way that had been proposed for FLA. In the case of children, the logical problem relates to the baffling complexity and uniformity of language acquisition outcomes, in light of the quantity and quality of input they are typically exposed to. In other words, how do typical human children (and not other species) come to acquire language in very similar ways, to very much the same degree (notwithstanding third-degree factors such as dialectal differences), without instruction, irrespective of differences in cognitive capacities (e.g., general intelligence, working memory)? How is it that children are able to produce utterances—and, most importantly, make errors—that do not (cannot) form part of the input they receive? The generative answer to these questions is that only by assuming some type of innate, domain-specific knowledge like UG can we begin to understand the discrepancies between the (never optimal) input children receive and the complex, rich adult grammars they target and successfully acquire. To be sure, much of the path of child acquisition can be accounted for on the basis of an interaction with environmental input and constraints traceable to domain-general cognition. However, the fact that not all of the complexity of linguistic computational grammars can be reduced to this interaction in light of the overwhelming success of virtually all children still leaves "little hope that much of the structure of the language can be learned by an organism initially uninformed as to its general character." (Chomsky, 1965: 58).

While uniformity in ultimate attainment across learners is much less robust in L2 acquisition, it is still the case that the input available to the learner often underrepresents, or underdetermines, the kind of subtle knowledge that L2ers nevertheless come to possess. And so, there is also a *logical problem* of explanation for adult L2 acquisition, even if the typical path of development and ultimately attained grammars do not display the same conformities overall as FLA (Schwartz, 1998). The input underrepresentation is compounded by the fact that most input consists of positive evidence, that is, naturalistic input (both in L1 and L2 acquisition) is made up of grammatical sentences, which means that the only direct evidence learners get is about what *can* be done in a particular grammar, but they are rarely—and definitely never reliably—provided with evidence of what *cannot* be done (i.e., negative evidence). This does not mean that L2 learners, especially in a classroom setting, are not corrected in various ways, both directly and indirectly (e.g., recasting). The type of correction given, however, is not always likely to induce grammatical changes at the level of representation, especially because it is typically inconsistent and obtains on the basis of needing to correct truth-value or due to a lack of intelligibility. To understand this, one need look no further than the most ubiquitous errors of L2 English, and the fact that they are fairly consistently corrected, to begin to appreciate the limitations of overt corrections in adult L2 acquisition. Obligatory morphology such as third person *-s* or past tense *-ed* are often omitted or overused by L2 learners—interestingly irrespective of their L1, although there is a clear L1 effect in terms of how this distributes. These properties are taught explicitly in a repeated fashion and are often corrected, yet they persist to a high degree. Details aside on how and why this happens, the point to be made is that mental L2 grammars have their own time course of development—as in L1 acquisition—despite what explicit correction might hope to achieve.

The argument that the linguistic input often underrepresents the actual complexity of the target grammar, also known as the *poverty of the stimulus* (PoS) problem (see Berwick, Chomsky & Piattelli-Palmarini, 2012; Berwick, Pietroski, Yankama & Chomsky, 2011; Kam

& Fodor, 2012; Crain, 2012; Lasnik & Lidz, 2017; Schwartz & Sprouse, 2013, for updated reviews of PoS in general and its applicability to L2 acquisition), has been one of the guiding questions in SLA research from a generative perspective, although, as we will see, whether or not UG remains accessible in adulthood to fill the gap between the input and the output of L2 acquisition has been, and continues to be, the source of much debate. Reasonably, much work in usage-based approaches to language has been dedicated to falsifying the basic claim of the PoS argument—i.e., that the input does indeed lack sufficient evidence of certain subtle contrasts that learners do eventually acquire. Most recent proposals argue that primary linguistic data might indeed contain indirect negative evidence of what have traditionally been defined as PoS properties, even if no utterance in the input explicitly exemplifies those properties (e.g., Lewis & Elman, 2001; Reali & Christiansen, 2003, 2005). However, simulations using sophisticated statistical learning have not yet succeeded in replicating the acquisition of this kind of fine-grained contrasts from arguably comparable input (see, e.g., Kam, Stoyneshka, Tornyova, Fodor & Sakas, 2008, in response to Reali & Christiansen, 2005). One of the issues that non-generative approaches have to address is that PoS is not merely articulated around the extremely low frequency of binary outcomes—i.e., the lack of direct evidence of whether something is allowed in the grammar or not—but also around very subtle conditions for optionality. In other words, some things are not just allowed or disallowed in the grammar: they are simply interpreted differently depending on tacit distinctions that vary across languages. Let us illustrate this with a well-known example of this type of properties which relates in ways to the EPP and the NSP discussed above—in whatever form a then-current theory uses to explain their general observations—precisely because it embodies a highly specific constraint on interpretation of overt pronouns in null-subject languages: the Overt Pronoun Constraint (OPC; Montalbetti, 1984).

Recall that in section 2, we ended our discussion of the NSP by stating that null-subject languages like Spanish or Turkish also respect the EPP, because even when subjects are phonetically null, they are recoverable from some combination of the verbal morphology and available discourse/context information. One might then be tempted to assume that null and overt subjects are equally acceptable in all contexts in, for example, Spanish, or that subjects are interpreted more or less in the same way whether or not they are phonetically realized. Neither of these assumptions would be correct. There are, indeed, well established patterns as to the general distribution of when overt and null subjects tend to be used pragmatically (e.g., overt pronouns in contrastive focus contexts), or when the grammar forces a null subject, such as in expletive contexts (e.g. subjects of existentials where there is no semantic meaning of the subject: __ *hay tres hombres en la sala.* '(There) are three men in the room.'

But, what about interpretation? Subject pronouns in English embedded clauses can be interpreted as referring back to a noun phrase (NP) in the main clause—whether this is a referential NP, a quantified expression like *someone* or *everybody*, or a *wh*-word/phrase—or, alternatively, to an extra-sentential antecedent that can be recovered from discourse without any grammatical restrictions, even if reference back to the matrix subject is preferred. Consider the examples in 6a-c and 7a-c (drawn from White, 2003):

(6) a. [Mary$_i$ thinks [that she$_i$ will win.]]
    b. [Everyone$_i$ thinks [that she$_i$ will win.]]
    c. [Who$_i$ thinks [that she$_i$ will win?]]

(7) a. Janet$_i$ is a great athlete. [Mary$_j$ thinks [that she$_i$ will win.]]
    b. Janet$_i$ is a great athlete. [Everyone$_j$ thinks [that she$_i$ will win.]]
    c. Janet$_i$ is a great athlete. [Who$_j$ thinks [that she$_i$ will win?]]

In 6a-c, the pronoun *she* is coreferential with the subject of the main clause, which in 6b is a quantified expression and in 6c is a *wh*-phrase. In 7a-c, on the other hand, *she* refers to Janet, an antecedent which can be found earlier in the discourse but does not belong to the same sentence as the pronoun. Because each of the sentences in 6 is identical in form to the second sentence in the corresponding example from 7, the hearer/reader needs to rely on contextual information to assign the correct referent.

Things, however, are not so straightforward in a null-subject language like Spanish. While both overt and null pronouns can have discourse antecedents (the type of referents we saw in 7), they behave differently when it comes to referring back to the main clause (matrix) subject. In short, null pronouns can have both referential and quantified NPs as their antecedents, whereas overt pronouns cannot refer back to a quantified expression (in theoretical jargon, they cannot have bound variable interpretations). Consider now the examples in 8 (for null pronouns) and 9 (for overt pronouns):

(8) a. [Marta$_i$ considera [que __ $_i$ debería entrar la primera.]]
   Marta considers that (null) should go in the first.
   'Marta considers that [Marta] should go in first.'

   b. [Alguna$_i$ considera [que __ $_i$ debería entrar la primera.]]
   Some(one) considers that (null) should go in the first.
   'Some of them consider that [they] should go in first.'

(9) a. [Marta$_i$ considera [que ella$_i$ debería entrar la primera.]]
   Marta considers that she should go in the first.
   'Marta considers that [Marta] should go in first.'

   b. *[Alguna$_i$ considera [que ella$_i$ debería entrar la primera.]]
   Some(one) considers that she should go in the first.
   'Some of them consider that [they] should go in first.'

As we can see, null pronouns in 8a-b admit both a referential (8a) and a quantified (8b) NP as their antecedent, whereas this correferential interpretation with a quantified expression is impossible for the overt pronoun in 9b: in fact, a sentence like 9b forces an discourse antecedent interpretation:

(10) [Alguna$_i$ considera [que ella$_j$ debería entrar la primera.]]
   Some(one) considers that she should go in the first.
   'Some of them consider that [she, i.e., someone else] should go in first.'

where the pronominal subject *ella* is interpreted to refer back to some antecedent in discourse, but crucially not to the quantifier *alguna*. In short, there is a highly specific restriction at play. Although Spanish has processing induced preferences in how this distributes, all null subjects can freely co-refer to all matrix and disjoint referent antecedents, especially in consideration of the discourse context. This, however, is not true of overt subjects. Embedded overt subjects cannot co-refer to the matrix clause only when the antecedent is a variable expression (quantified NP/wh-phrase). Of course, this is never taught. In fact, it is a fact about null subject languages that flies under the radar unless one is a linguist.

What makes this property such a subtle contrast is the fact that there is no apparent reason why the string in 9b should be ungrammatical. However, the string is exactly the same as in 10, and yet no direct evidence in the input will suggest to the learner that some readings (coreferential with the main clause subject) are not possible in some sub-cases (quantified expression in the subject of the main clause) of a sub-type (overt pronoun in the subject of the

embedded clause) of embedded clauses in Spanish (and other null subject languages). And in fact, discourse context between two interlocutors would not necessarily help either, because taking a disjoint versus a matrix antecedent interpretation typically would not cause an obvious breakdown in communication, even if the two speakers unbeknownst to themselves understand distinctly the same utterance.

Although many have examined this property since, Pérez-Leroux and Glass (1997, 1999) and Kanno (1997, 1998) were the first to focus on the acquisition of the OPC in L2 Spanish and L2 Japanese, respectively, by native speakers of English. These are particularly relevant groups because, as we have just seen, the OPC does not apply in English, and it is never taught in Spanish or Japanese lessons (see Kanno, 1997, and Pérez-Leroux & Glass, 1997, for discussion). In sum, the OPC does not receive support from direct evidence in the L2 input, is not explicitly taught in these learners' lessons, and cannot be transferred from their L1, which makes it a perfect example of a PoS property and thus a good candidate to test whether UG guides, or constrains, the acquisition of non-native languages.

Kanno (1997) tested the interpretation of sentences of the type 6-10 above in the L2 Japanese of 28 native speakers of English, as compared to the judgments of 20 L1 Japanese speakers. She found that, like the natives, L2 learners majoritarily rejected a quantified NP as the antecedent of an overt pronoun in the embedded clause (87% of the time, as compared to 98% for the native speakers). Moreover, native and non-native speakers even displayed similar preferences when both interpretations were optionally available for the overt pronoun, that is, when the main clause subject was a referential NP. In those cases, both groups chose a coreferential interpretation only half of the time—the other half, they selected a discourse antecedent. Kanno's (1997) results are particularly relevant because they not only point to the acquisition of a subtle, PoS property, but even to similar preferences in anaphora resolution where no constraints on distribution or interpretation seem to be in place in the native grammar.

Similarly, Pérez-Leroux and Glass (1997, see also discussion in Pérez-Leroux & Glass, 1999) tested the same constraint in the L2 Spanish of three groups of non-native speakers (total n = 98) divided by proficiency, as compared to a control group of native speakers of different varieties of Latin American and European Spanish. The experiment, a translation task, elicited production data based on a fixed interpretation that was strongly suggested by the context provided before each sentence. Some contexts promoted a bound-variable interpretation (i.e., they suggested that the null or overt pronoun should be coreferential with the main clause subject, whether this was a referential or a quantified NP), whereas others fixated an interpretation in which the null/overt pronoun in the embedded clause referred back to a discourse antecedent. An example is provided in 11 (Pérez-Leroux & Glass, 1999):

(11) a. Referential story
In the O.J. Simpson trial, it is clear that the press has a negative bias against the defendant in their reporting. Some journalist said that he was a wifebeater.
• To translate: 'But no journalist said that **he** is guilty.'

b. Bound-variable story
The court charged that some journalists had been in contact with the jurors. Several of them were questioned by the judge.
• To translate: 'No journalist admitted that **he** had talked to the jurors.'

The logic of the experiment is simple. If participants obey the OPC, they should never translate the pronominal subject of the embedded clause—bolded in our reproduction of the examples—as an overt pronoun in 11b, where the pronoun is forced to refer back to a quantified NP. However, they should be able to use both null and overt pronouns in 11a, where the referential

NP is a possible antecedent for either. Pérez-Leroux and Glass found that all groups made a distinction between those contexts in which only null pronouns should be used (bound-variable stories) and those in which either an overt or a null pronoun were acceptable (referential stories). While some of the learner groups displayed some violations of the OPC, this did not differ significantly from the native controls, who did in fact show some violations themselves—the authors attribute this to the effect of Caribbean Spanish, one of the varieties present in the sample, which overuses overt pronouns with respect to other varieties. Importantly, Pérez-Leroux and Glass's (1997) results demonstrate that the OPC is operative from very early on in L2 development. Taken together, the results of these two studies strongly suggest that some type of domain-specific knowledge—not accessible via L1 transfer—actively constrains the acquisition process. The case is indeed compelling: from very early stages, L2 learners unfamiliar with any language where the OPC operates, and with no indication of its existence from their classroom instruction, manage to acquire (i) a restriction on the interpretation of a subset within a subset of *grammatical* sentences, for which there is no direct (negative) evidence in the input stream, and (ii) a similar distribution of anaphora resolution preferences in those contexts where both overt and null pronouns can be interpreted in similar ways. It is difficult to account for this type of evidence on the basis of L2 input and domain-general cognition alone, that is, without positing the existence of some innate knowledge that is able to fill in the gap between the notable scarcity of evidence, linguistic or otherwise, in the input and these learners' successful acquisition of the OPC.

Empirical evidence of this and other PoS properties being acquired by learners who are exposed to an L2 after puberty provides support for two different but interrelated positions. The first, relevant to cross-paradigm debates, is the one we have discussed as distinctive of GenSLA approaches: that domain-specific knowledge of a UG type must be invoked if we are to explain the relative ease with which L2 learners overcome this and other similar learnability problems. The second position, which applies internally to GenSLA, is that access to UG remains intact throughout the lifespan and across multiple iterations of language acquisition—i.e., L2/L3/L4/L*n*. From very early on, differences in developmental sequence and ultimate attainment between L1 and L2 acquisition were ascribed by numerous authors to a complete or partial inaccessibility of the same underlying mechanisms that guide child L1 acquisition (e.g., Abrahamsson & Hyltenstam, 2008, 2009; Bylund, Abrahamsson & Hyltenstam, 2012, 2013; Bley-Vroman, 1989, 2009; Clahsen & Muysken, 1989; Coppetiers, 1987; DeKeyser, 2000; Granena & Long, 2013; Hawkins & Casillas, 2008; Hawkins & Chan, 1997; Johnson, 1992; Johnson & Newport, 1989; Long, 2005; Meisel, 2011; Schachter, 1988; Tsimpli & Dimitrakopoulou, 2007). These arguments dovetail with claims that a critical period (Lenneberg, 1967) exists for language acquisition, direct evidence of which had become available in the late 1970s through the case of Genie, a feral child who had been abused and deprived of the most basic linguistic interaction (e.g., Curtiss, 1977). Essentially, the Critical Period Hypothesis (CPH) as applied to L2 acquisition argued that, due to a decrease in brain plasticity after a certain age (loosely identified with puberty), adults are unable to acquire new languages in qualitatively the same way as children do (e.g., DeKeyser, 2000; Franceschina, 2005; Long, 2005).

Two main bodies of evidence problematize the above type of claims. The first is that extremely successful—i.e., native-like—adult L2 learners are indeed uncommon, but also not truly exceptional. However, a strong hypothesis like the CPH should not tolerate such exceptions, because its core argument is universally applicable: all brains mature, and therefore any maturational constraint one wishes to posit will inevitably encompass all adult learners. Under such a logic, that a majority of L2 learners *do not* achieve native-like proficiency must mean they *cannot*; any evidence to the contrary—i.e., any native-like L2 learner or the acquisition of specific properties that should not be acquirable by a much larger cohort of L2

learners (not just the super talented and highly advanced ones)—escapes the scope of such a position's predictions and poses a serious challenge to it (see Rothman, 2008; Schwartz, 1986, for similar arguments). There of course exists the possibility that different neurocognitive mechanisms underlie seemingly identical behavior. In other words, it might be that successful L2 learners manage to perform in very much the same way as natives making use of fundamentally different tools (e.g., Clahsen & Felser, 2006a, 2006b, 2017; Paradis, 2009; Prévost & White, 2000; Ullman, 2005, 2016). The second body of evidence is in fact relevant to this claim. First, research in cognitive neuropsychology has shown that the existence of a post-pubescent cutoff in neuroplasticity or even very sharp declines are simply not so (Fuchs & Flügge, 2014, for review). Second, asserting that different cognitive/processing mechanisms underlie the linguistic performance of native and non-native speakers generates very specific predictions that are amenable to testing directly through methodologies that are increasingly familiar to the field—electro- and magnetoencephalography (EEG, MEG), functional magnetic resonance imaging (fMRI), etc. Together with the improved sensitivity of implicit, real-time behavioral measures such as eye-tracking, online processing methodologies allow us to evaluate the claim that native and non-native language use are underlain by neuro-functionally different processes, despite occasional appearance of convergence. Similarly to the previous claim, such a theory is falsified if L2 learners are shown to (i) match native speakers in performance, while (ii) displaying comparable indices of online processing. A growing body of evidence suggests that this might indeed be the case (see, e.g., Roberts, González Alonso, Pliatsikas & Rothman, 2018, for discussion). Indeed, the field of non-native processing research, to which we now turn, is a good friend to GenSLA and vice versa.

4. GenSLA and language processing

Beginning in the late 1990s and early 2000s, L2 researchers began in earnest to utilize experimental methodologies from the fields of psycholinguistics and neurolinguistics to investigate not only L2 knowledge and representation but also how such knowledge is utilized during real-time language processing. This involved expanding the set of methodologies used in GenSLA research from 'offline' measures, such as acceptability judgments, that index the final interpretation or judgment given to a sentence, to 'online' measures, such as reaction times, that allow the researcher to investigate the moment-to-moment processes involved in language processing as a sentence unfolds in real-time (see Roberts, this volume, for further discussion of psycholinguistic and neurolinguistic methods).

Early research in this regard included studies on the processing of so-called wh-dependencies (e.g., Juffs & Harrington 1995, 1996). Consider, for example, (12a) and (12b). In (12a) the verb 'read' and its direct object 'the book' are adjacent to each other. In the wh-question (12b), 'which book' is also interpreted as the direct object of 'read', but does not appear adjacent to it. Correct interpretation in this case requires a linguistic dependency to be formed between the verb and the displaced wh- constituent. Although wh- questions can span several clauses, as in (12c), subjacency or 'island' constraints restrict wh- dependency formation (Ross, 1967). For example, a dependency cannot be formed between a wh-constituent and a verb inside a relative clause, as in (12d). Whether L2 learners can acquire knowledge of restrictions on grammatical and ungrammatical wh- dependencies has been widely studied in the GenSLA literature (e.g. Johnson & Newport, 1991; Martohardjono, 1993; Schachter, 1990; White, 1992). Juffs and Harrington (1995, 1996) utilized self-paced reading to investigate how processing influences wh- dependency formation in L2 learners.

(12a)   The boy read the book.

(12b)   Which book did the boy read?
(12c)   Which book did the boy say that the girl read?
(12d)   *Which book did the boy who read?

Two types of sentences that Juffs and Harrington examined include those in (13). In (13a), the wh- constituent 'who' must be interpreted as the subject of 'to fire' while in (13b) it is interpreted as its object. Interestingly, as first observed by Schachter and Yip (199), L2 learners of English are less accurate in accepting sentences like (13b) compared to (13a), even though both are grammatical. This might be taken as evidence suggesting that L2 learners have difficulty acquiring knowledge of wh-dependencies in English, but Juffs and Harrington explored whether a processing-based explanation can account for the judgments given by L2 learners.

(13a)   Who does Tom expect to fire the manager?
(13b)   Who does Tom expect to fire?

In particular, although in (13a) 'who' is ultimately interpreted as the subject of 'to fire', arriving at this interpretation during incremental sentence processing may involve several stages of reanalysis. For example, during processing 'who' may initially be interpreted as the direct object of 'expect' ('Who does Tom expect?') and then the direct object of 'to fire' ('Who does Tom expect to fire?'). It is only when 'the manager' is reached that 'who' can unambiguously be interpreted as the subject of 'to fire'. Based on reaction time data, Juffs and Harrington argued that it is this reanalysis during processing that causes L2ers to judge such sentences as ungrammatical, rather than an inability to acquire the relevant knowledge of wh-dependencies. These results indicate that, like L1 speakers, L2 learners process wh-dependencies incrementally (see also Williams, Mobius & Kims, 2001), and provide an example of how parsing considerations during real-time sentence processing can influence our understanding of the knowledge acquired by L2 learners.

In their influential review of this and other related research on L2 sentence processing, Clahsen and Felser (2006a, 2006b) proposed the *Shallow Structure Hypothesis* (SSH) as an account of the similarities and differences in L1 and L2 processing. The SSH posits that L2ers have difficulty utilizing syntactic information during sentence processing, and instead rely more on semantic and discourse-level information. The hypothesis that syntactic processing might be the locus of difficulty during L2 sentence parsing sparked considerable interest in the SLA community, and motivated a great deal of research over the following decade that increasingly used online methodologies to investigate the role of syntactic and non-syntactic information during L2 acquisition and processing.

For example, Felser, Cunnings, Batterham and Clahsen (2012) adopted a design previously used in L1 processing by Traxler and Pickering (1996) to investigate the application of island constraints during L2 processing. In (14a) and (14b), 'the magazine' and 'the shampoo' respectively are both ultimately the direct object of 'about' but may initially be interpreted as the direct object of 'read' during incremental processing. While both (14a) and (14b) are equally plausible at 'about', (14b) is implausible at 'read'. In (14c) however, this initial dependency at 'read' should be ruled out because it appears inside of a relative clause. Felser et al. (2012) monitored the eye-movements of L1 English speakers and German L2 English learners as they read sentences like (14) and observed longer reading times at 'read' in (14b) than (14a) in both groups, suggesting both L1 and L2 groups formed a dependency at the earliest available point. This contrast in plausibility at 'read' was not seen in sentences like (14c), suggesting that both groups did not attempt to form a dependency when the verb appeared inside a relative clause. These results suggest L2 learners are able to utilize

knowledge of island constraints to restrict dependency resolution during processing (see also Omaki & Schulz, 2011; but see Kim, Baek & Tremblay (2015) for a potential influence of transfer).

(14a)   Everyone liked the magazine that the hairdresser read extensively
        and with such enormous enthusiasm about before going to the salon.
(14b)   Everyone liked the shampoo that the hairdresser read extensively
        and with such enormous enthusiasm about before going to the salon.
(14c)   Everyone liked the magazine/the shampoo that the hairdresser who read extensively
        and with such enormous enthusiasm bought before going to the salon.

In investigating the role of syntactic information during L2 processing, other studies examined how L2ers utilize syntactic binding constraints on anaphora resolution during sentence comprehension (Felser & Cunnings, 2012; Felser, Sato & Bertenshaw, 2009; Patterson, Trompelt & Felser, 2014). Consider (15a), for example, where the reflexive 'himself' must refer to 'the boy' and (15b), where the pronoun 'him' must refer to 'the man'. In the linguistics literature, constraints on the interpretation of reflexives and pronouns have typically been described in terms of syntactic binding constraints (Chomsky, 1981), such that reflexives, but not pronouns, must be bound by a local antecedent (i.e. 'the boy').

(15a)   The man said that the boy hurt himself.
(15b)   The man said that the boy hurt him.

In line with the long tradition of GenSLA research investigating whether L2ers can or cannot acquire such constraints (see Hawkins, 2001; White, 2003), Felser and Cunnings (2012) investigated the processing of binding constraints on reflexives in texts like (16). They found that L1 English speakers had longer reading times at the reflexive in (16b), when it mismatched with the stereotypical gender of the local antecedent 'the soldier', compared to (16a), when there was a stereotypical gender match (replicating Sturt, 2003). When they first encountered the reflexive during reading however, German L2 learners had longer reading times when the non-local antecedent (She/He) mismatched the gender of the reflexive. The L2ers did indicate nativelike knowledge of binding constraints in an offline task however, and their reading times after the reflexive were affected by the stereotypical gender manipulation. These results suggest the L2ers had acquired the binding constraints on reflexives in English, but temporarily violated them during processing.

(16a)   James/Helen has worked in the army hospital for years. He/She noticed that
        the soldier had wounded himself while on duty in the Far East.
(16b)   James/Helen has worked in the army hospital for years. He/She noticed that
        the soldier had wounded herself while on duty in the Far East.

In addition to studies that have manipulated gender congruence as a means of testing the application of syntactic binding constraints during processing, a number of studies have manipulated gender or number congruence to investigate L2 processing of morphosyntactic agreement. Much of this research has been motivated by long-standing questions in the GenSLA literature regarding whether L2 learners can acquire syntactic features not instantiated in their L1, and has adopted paradigms testing sentences like (17). Here, participants' reading times at critical regions of text are recorded as an implicit measure of whether L2ers are sensitive to the (un)grammaticality of sentences like (17a) and (17b). In (17), longer reading

times at 'was' in ungrammatical (17b) than grammatical (17a) would be taken as evidence of L2 acquisition of the relevant agreement feature.

(17a)   The boy unsurprisingly was late for school again.
(17b)   *The boys unsurprisingly was late for school again.

The extent to which L2 learners show nativelike sensitivity to such agreement violations has been widely debated. Jiang (2004, 2007), for example, claimed that Chinese L2 learners of English are insensitive to number agreement violations during processing, suggesting L2ers may have difficulty in acquiring agreement features (in this case number) not instantiated in the L1. A number of studies have since investigated which factors may influence L2 learners' nativelike sensitivity to agreement violations (e.g., Coughlin & Tremblay, 2013; Foote, 2011; Keating, 2009; Sagarra & Herschensohn, 2010, 2011, 2013). This has included work that has utilized neurolinguistic techniques such as event-related brain potentials (ERPs), where electrical activity in the brain is recorded as an implicit measure of language processing. Alemán Bañón, Fiorentino and Gabriele (2014), for example, tested grammatical and ungrammatical gender agreement in Spanish, as in (18).

(18a)   El cuadro es auténtico y el grabado también.
        'The painting-MASC is authentic-MASC and the engraving too.'
(18b)   El cuadro es auténtica y el grabado también.
        'The painting-MASC is authentic-FEM and the engraving too.'

In (18a), the form of the adjective 'auténtico' matches the gender of the noun 'El cuadro' and as such the sentence is grammatical, while (18b) is ungrammatical as the adjective is feminine while the noun is masculine. In recording participants' brain responses to such sentences, Alemán Bañón et al. (2014) were interested in testing whether both L1 and L2 speakers exhibit the so-called P600 effect (e.g., Friederici, Pfeiffer, & Hahne, 1993; Osterhout & Holcomb, 1992; Osterhout, McKinnon, Bersick, & Corey, 1996; Kaan, Harris, Gibson & Holcomb 2000) as an index of sensitivity to the (un)grammaticality of (18 a/b) at the critical adjective. Alemán Bañón et al. indeed reported P600 effects for ungrammatical sentences for both L1 and L2 Spanish speakers. These results were interpreted as indicating that L2 learners can indeed acquire morphosyntactic features (in this case gender) that are not instantiated in the L1 (see also Alemán Bañón, Miller & Rothman, 2017).

In sum, the past decade of research in L2 sentence processing has brought considerable new insight into the role of processing in L2 acquisition, and has led some researchers to reconsider the source of potential differences between L1 and L2 processing. In a recent review of research on L2 comprehension, Clahsen and Felser (2017) maintained the SSH as a viable account of L2 sentence processing, but alternative accounts have also been proposed. Cunnings (2017) proposed that L2ers construct similarly well-specified syntactic structures during processing as L1ers, but argued that L1/L2 differences that persist at high levels of L2 proficiency are best described in how information held in memory during sentence processing is accessed rather than shallow syntactic parsing. Other GenSLA (friendly) accounts have claimed that the primary source of difficulty during L2 processing relates to how lexical information is accessed during processing (Hopp, 2013) or a reduced ability to predict and anticipate upcoming information (Grüter, Rohde & Schafer, 2017). These different accounts provide different perspectives on the role of sentence processing in SLA, and will no doubt motivate further research that will provide new insight into L2 acquisition and processing in the future.

5. Conclusions

As can be appreciated in this chapter via a rather reduced (by necessity) review of a subset of available GenSLA work in acquisition and processing, the remit of GenSLA is mainly focused on understanding the constraints on and the shape of mental L2 linguistic competence and how such knowledge interacts with L2 language processing. It is probably fair to say that while the paradigm is not focused on L2 language learning in the traditional sense, there is no question that the two are inherently related. Earnest and promising attempts at bridging GenSLA with language learning/teaching in the past few years in particular have been made (e.g., Marsden & Slabakova, 2017; Marsden, Whong & Gil, 2017; Whong, Gil & Marsden 2013). The links, nevertheless, are inherent and have thus always existed. Uncovering how L2 acquisition and processing unfold in a cognitive sense is important for L2 language learning and classroom practice because they inform what is potentially more difficult/challenging in L2 learning, the relative role of certain variables that will either need to be compensated for or can be excluded from further consideration in pedagogical construction and intervention, what needs to be explicitly taught and potentially what, over time and good quality exposure, comes for free, and so much more. Modeling language learning and application of what cognitive research reveals can increase L2 learning success if properly applied; after all, time is a rich and scarce commodity, and so maximizing its use most effectively in adult L2 language teaching is not to be understated. One variable that will contribute to the best use of time and better construction of more effective pedagogical materials is the increased understanding of how the mind actually acquires and processes language in adulthood. Understanding if it is truly fundamentally different, and if so how, will reveal better paths for applied language learning and teaching.

In this chapter, we have seen that there are two observable facts one should attempt to reconcile in order to provide an explanatorily adequate theory of L2 acquisition and processing in a cognitive sense, which can thus provide the grounds for an informed applied linguistics agenda for language teaching. First, that despite the ubiquity in L2 differences as compared to FLA, L2 grammars instantiate much more widely gems of successful acquisition and indications of fundamentally similar processing, which should not be expected under critical and sensitive period approaches. As we do not want to miss the forest for the trees by focusing only on global differences in L2 acquisition, it is important to herald all the predictions of claiming there is a critical/sensitive period for L2 syntax when evidence abounds that problematizes it. Such a claim does not simply intend that L2 syntax will look different from L1 syntax and/or be processed differently, it also claims that new properties such as the OPC, detailed in section 3, should not obtain in L2 grammars if not transferable from the L1—yet, as we have seen, they reliably do. Second, that despite this testament to the possibility of native-like proficiency, the majority of L2 learners reach a stable state at a level that is not comparable to native speakers. Since tapping underlying processing mechanisms is the only reliable way to determine if these differences are indeed representational or simply operational (or neither, or a combination of the two), GenSLA will continue, as it has recently, to direct considerable attention to processing methodologies. Doing so also helps build stronger bridges with applied linguistics.

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