Chapter 3
Frequency-based grammar and the acquisition of tense-aspect in L2 learning[1]

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1. Frequency and language cognition

The last 50 years of Psycholinguistic research has demonstrated language processing to be exquisitely sensitive to usage frequency at all levels of language representation: phonology and phonotactics, reading, spelling, lexis, morphosyntax, formulaic language, language comprehension, grammaticality, sentence production, and syntax (Ellis 2002a). Language knowledge involves statistical knowledge, so humans learn more easily and process more fluently high frequency forms and 'regular' patterns which are exemplified by many types and which have few competitors. Psycholinguistic perspectives thus hold that language learning is the implicit associative learning of representations that reflect the probabilities of occurrence of form-function mappings. Frequency is a key determinant of acquisition because 'rules' of language, at all levels of analysis from phonology, through syntax, to discourse, are structural regularities which emerge from learners' lifetime unconscious analysis of the distributional characteristics of the language input.

It is these ideas which underpin the last 30 years of investigations of language cognition using connectionist and statistical models (Christiansen and Chater 2001; Elman, et al. 1996; Rumelhart and McClelland 1986), the competition model of language learning and processing (Bates and MacWhinney 1987; MacWhinney 1987b, 1997), the investigation of how frequency and repetition bring about form in language and how probabilistic knowledge drives language comprehension and production (Bod, Hay, and Jannedy 2003; Bybee and Hopper 2001; Ellis 2002a, 2002b; Jurafsky 2002; Jurafsky and Martin 2000), and the proper empirical investigations of the structure of language by means of corpus analysis.

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Frequency, learning, and language come together in usage-based approaches which hold that we learn linguistic constructions while engaging in communication, the "interpersonal communicative and cognitive processes that everywhere and always shape language" (Slobin 1997, Niemeier, Chapter 1 this volume). Constructions are form-meaning mappings, conventionalized in the speech community, and entrenched as language knowledge in the learner's mind. They are the symbolic units of language relating the defining properties of their morphological, syntactic, and lexical form with particular semantic, pragmatic, and discourse functions (Bates and MacWhinney 1987; Bybee 2008; Croft 2001; Croft and Cruise 2004; Goldberg 1995, 2003, 2006; Lakoff 1987; Langacker 1987; Robinson and Ellis 2008; Tomasello 2003). Goldberg's (2006) Construction Grammar argues that all grammatical phenomena can be understood as learned pairings of form (from morphemes, words, idioms, to partially lexically filled and fully general phrasal patterns) and their associated semantic or discourse functions: "the network of constructions captures our grammatical knowledge *in toto*, i.e. It's constructions all the way down" (Goldberg 2006, p. 18). Such beliefs, increasingly influential in the study of child language acquisition, have turned upside down generative assumptions of innate language acquisition devices, the continuity hypothesis, and top-down, rule-governed, processing, bringing back data-driven, emergent accounts of linguistic systematicities. Constructionist theories of child language acquisition use dense longitudinal corpora to chart the emergence of creative linguistic competence from children's analyses of the utterances in their usage history and from their abstraction of regularities within them (Goldberg 1995, 2003, 2006; Tomasello 2003, 1998). Children typically begin with phrases whose verbs are only conservatively extended to other structures. A common developmental sequence is from formula to low-scope slot-and-frame pattern, to creative construction.

2. Frequency and concept learning

It is human categorization ability that provides the most persuasive testament to our incessant unconscious tallying of associations. We know that natural categories are fuzzy rather than monothetic. Wittgenstein's (1953) consideration of the concept *game* showed that no set of features that we can list covers all the things that we call games, ranging as the exemplars variously do from soccer, through chess, bridge, and poker, to solitaire. Instead, what organizes these exemplars into the *game* category is a set of family resemblances among these members – son may be like mother, and mother like sister, but in a very different way. And we learn about these families, like our own, from experience. Exemplars are similar if they have many features in common and few distinctive attributes (features belonging to one but not the other); the more similar are two objects on these quantitative grounds, the faster are people at judging them to be similar (Tversky 1977). Prototypes, exemplars which are most typical of a category, are those which are similar to many members of that category and not similar to members of other categories. Again, the operationalisation of this criterion predicts the speed of human categorization performance – people more quickly classify as *birds* sparrows (or other average sized, average colored, average beaked, average featured specimens) than they do birds with less common features or feature combinations like kiwis or penguins (Rosch and Mervis 1975; Rosch, Mervis, Gray, Johnson, and Boyes-Braem 1976).

Prototypes are judged faster and more accurately, even if they themselves have never been seen before – someone who has never seen a sparrow, yet who has experienced the rest of the run of the avian mill, will still be fast and accurate in judging it to be a bird (Posner and Keele 1970). Such effects make it very clear that although people do not go around consciously counting features, they nevertheless have very accurate knowledge of the underlying frequency distributions and their central tendencies. Cognitive theories of categorization and generalization show how schematic constructions are abstracted over less schematic ones that are inferred inductively by the learner in acquisition (Harnad 1987; Lakoff 1987; Taylor 1998).

3. Frequency and second language acquisition

Language learners, L1 and L2 both, share the goal of understanding language and how it works. Since they achieve this based upon their experience of language usage, there are many commonalities between first and second language acquisition that can be understood from corpus analyses of input and cognitive- and psycho- linguistic analyses of construction acquisition following associative and cognitive principles of learning and categorization. Therefore usage-based approaches, cognitive linguistics, and corpus linguistics are increasingly influential in L2A research too (Collins and Ellis 2009; Ellis 1998, 2003; Ellis and Cadierno 2009; Robinson and Ellis 2008), albeit with the twist that since they have previously devoted considerable resources to the estimation of the characteristics of another language – the native tongue in which they have considerable fluency – L2 learners' computations and inductions are often affected by transfer, with L1-tuned expectations and selective attention (Ellis 2006b) blinding the acquisition system to aspects of the L2 sample, thus biasing their estimation from naturalistic usage and producing the limited attainment that is typical of adult L2A. L2A is different from L1A in that it involves processes of construction and *re*construction.

4. Construction learning as associative learning from usage

If constructions as form-function mappings are the units of language, then language acquisition involves inducing these associations from experience of language usage. Constructionist accounts of language acquisition thus involve the distributional analysis of the language stream and the parallel analysis of contingent perceptual activity, with abstract constructions being learned from the conspiracy of concrete exemplars of usage following statistical learning mechanisms (Christiansen and Chater 2001) relating input and learner cognition. Psychological analyses of the learning of constructions as form-meaning pairs is informed by the literature on the associative learning of cue-outcome contingencies where the usual determinants include: factors relating to the form such as frequency and salience; factors relating to the interpretation such as significance in the comprehension of the overall utterance, prototypicality, generality, and redundancy; factors relating to the contingency of form and function; and factors relating to learner attention, such as automaticity, transfer, overshadowing, and blocking (Ellis 2002a, 2003, 2006a, 2008b). These various psycholinguistic factors conspire in the acquisition and use of any linguistic construction.

These determinants of learning can be usefully categorized into factors relating to (1) input frequency (type-token frequency, Zipfian distribution, recency), (2) form salience and perception, (3) prototypicality of meaning and redundancy), and (4) contingency of form-function mapping.

4.1. Input frequency

4.1.1. Construction frequency

Frequency of exposure promotes learning. Ellis' (2002) review illustrates how frequency affects the processing of phonology and phonotactics, reading, spelling, lexis, morphosyntax, formulaic language, language comprehension, grammaticality, sentence production, and syntax. That language users are sensitive to the input frequencies of these patterns entails that they must have registered their occurrence in processing. These frequency effects are thus compelling evidence for usage-based models of language acquisition that emphasize the role of input.

4.1.2. *Type and token frequency*

Token frequency counts how often a particular form appears in the input. Type frequency, on the other hand, refers to the number of distinct lexical items that can be substituted in a given slot in a construction, whether it is a word-level construction for inflection or a syntactic construction specifying the relation among words. For example, the "regular" English past tense *-ed* has a very high type frequency because it applies to thousands of different types of verbs, whereas the vowel change exemplified in *swam* and *rang* has much lower type frequency. The productivity of phonological, morphological, and syntactic patterns is a function of type rather than token frequency (Bybee and Hopper 2001). This is because: (a) the more lexical items that are heard in a certain position in a construction, the less likely it is that the construction is associated with a particular lexical item and the more likely it is that a general category is formed over the items that occur in that position; (b) the more items the category must cover, the more general are its criterial features and the more likely it is to extend to new items; and (c) high type frequency ensures that a construction is used frequently, thus strengthening its representational schema and making it more accessible for further use with new items (Bybee and Thompson 2000). In contrast, high token frequency promotes the entrenchment or conservation of irregular forms and idioms; the irregular forms only survive because they are high frequency. These findings support language's place at the center of cognitive research into human categorization, which also emphasizes the importance of type frequency in classification.

4.1.3. *Zipfian distribution*

In the early stages of learning categories from exemplars, acquisition is optimized by the introduction of an initial, low-variance sample centered upon prototypical exemplars (Elio and Anderson 1981, 1984). This low variance sample allows learners to get a fix on what will account for most of the category members. The bounds of the category are defined later by experience of the full breadth of exemplar types. Goldberg Casenhiser and Sethuraman (2004) demonstrated that in samples of child language acquisition, for a variety of verb-argument constructions (VACs), there is a

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strong tendency for one single verb to occur with very high frequency in comparison to other verbs used, a profile which closely mirrors that of the mothers' speech to these children.

In natural language, Zipf's law (Zipf 1935) describes how the highest frequency words account for the most linguistic tokens: *the* constitutes nearly 7% of the Brown Corpus of English usage, *to* more than 3%; while about half the total vocabulary of about 50,000 words are hapax legomena: words that occur only once in the corpus. If p_f is the proportion of words whose frequency in a given language sample is f, then $p_f \sim f^{-\beta}$, with $\beta \approx 1$. Zipf (1949) showed this scaling relation holds across a wide variety of language samples. Subsequent research has shown that many language events (e.g., frequencies of phoneme and letter strings, of words, of grammatical constructs, of formulaic phrases, etc.) across scales of analysis follow this law (Ferrer i Cancho and Solé 2001, 2003). It has strong empirical support as a linguistic universal and has important implications for language structure, use, and acquisition.

Goldberg et al. (2004) show that Zipf's law applies within VACs too, and they argue that this promotes acquisition: tokens of one particular verb account for the lion's share of instances of each particular argument frame; this pathbreaking verb also is the one with the prototypical meaning from which the construction is derived (see also Ninio 1999, 2006). Ellis and Ferreira-Junior (2009a, 2009b) investigate effects upon naturalistic second language acquisition of type/token distributions in the islands comprising the linguistic form of English verb-argument constructions (VACs: VL verb locative, VOL verb object locative, VOO ditransitive) in the ESF corpus (Perdue 1993). They show that in the naturalistic L2A of English, VAC verb type/token distribution in the input is Zipfian and learners first acquire the most frequent, prototypical and generic exemplar (e.g. *put* in VOL, *give* in VOO, etc.). Their work further illustrates how acquisition is affected by the frequency and frequency distribution of exemplars within each island of the construction (e.g. [Subj V Obj $\text{Obl}_{\text{path/loc}}$]), by their prototypicality, and, using a variety of psychological (Shanks 1995) and corpus linguistic association metrics (Gries and Stefanowitsch 2004; Stefanowitsch and Gries 2003), by their contingency of form-function mapping. Ellis and Larsen-Freeman (2009a) describe connectionist serial-recurrent network models of these various factors as they play out in the emergence of constructions as generalized linguistic schema from their frequency distributions in the input.

This fundamental claim that Zipfian distributional properties of language usage helps to make language learnable has thus begun to be explored for these three verb argument constructions, at least. Ellis and O'Donnell (2012) are exploring its generality across a wide range of VACs in 100 million words of English.

4.1.4. Recency

Language processing also reflects recency effects. This phenomenon, known as priming, may be observed in phonology, conceptual representations, lexical choice, and syntax (Pickering and Ferreira 2008). Syntactic priming refers to the phenomenon of using a particular syntactic structure given prior exposure to the same structure. This behavior has been observed when speakers hear, speak, read or write sentences (Bock 1986; Pickering 2006; Pickering and Garrod 2006). For L2A, Gries and Wulff (2005) showed (i) that advanced L2 learners of English showed syntactic priming for ditransitive (e.g.,

(*The racing driver showed the helpful mechanic*) and prepositional dative (e.g., *The racing driver showed the torn overall . . .*) argument structure constructions in a sentence completion task, (ii) that their semantic knowledge of argument structure constructions affected their grouping of sentences in a sorting task, and (iii) that their priming effects closely resembled those of native speakers of English in that they were very highly correlated with native speakers' verbal subcategorization preferences whilst completely uncorrelated with the subcategorization preferences of the German translation equivalents of these verbs. There is now a growing body of research demonstrating such L2 syntactic priming effects (McDonough 2006; McDonough and Mackey 2006; McDonough and Trofimovich 2008).

4.2. Form (salience and perception)

The general perceived strength of stimuli is commonly referred to as their salience. Low salience cues tend to be less readily learned. Ellis (2006a, 2006b) summarized the associative learning research demonstrating that selective attention, salience, expectation, and surprise are key elements in the analysis of all learning, animal and human alike. As the Rescorla-Wagner (1972) model encapsulates, the amount of learning induced from an experience of a cue-outcome association depends crucially upon the salience of the cue and the importance of the outcome.

Many grammatical meaning-form relationships, particularly those that are notoriously difficult for second language learners like grammatical particles and inflections such as the third person singular *-s* of English, are of low salience in the language stream. For example, some forms are more salient: '*today*' is a stronger psychophysical form in the input than is the morpheme '-*s*' marking 3rd person singular present tense, thus while both provide cues to present time, *today* is much more likely to be perceived, and -*s* can thus become overshadowed and blocked, making it difficult for second language learners of English to acquire (Ellis 2006b, 2008a; Goldschneider and DeKeyser 2001).

4.3. Prototypicality of meaning and redundancy

4.3.1. Prototypicality of meaning

Categories have graded structure, with some members being better exemplars than others. In the prototype theory of concepts (Rosch and Mervis 1975; Rosch, et al. 1976), the prototype as an idealized central description is the best example of the category, appropriately summarizing the most representative attributes of a category. As the typical instance of a category, it serves as the benchmark against which surrounding, less representative instances are classified. The greater the token frequency of an exemplar, the more it contributes to defining the category, and the greater the likelihood it will be considered the prototype. The best way to teach a concept is to show an example of it. So the best way to introduce a category is to show a prototypical example. Ellis and Ferreira-Junior (2009a) show that the verbs that second language learners first used in particular VACs are prototypical and generic in function (*go* for VL, *put* for VOL, and *give* for VOO). The same has been shown for child language acquisition, where a small group of semantically general verbs, often referred to as *light verbs* (e.g., *go*, *do*, *make*, *come*) are learned early (Clark 1978; Ninio 1999; Pinker 1989). Ninio argues that, because most of their semantics consist of some schematic notion of transitivity with the addition of a minimum specific element, they are semantically suitable, salient, and frequent; hence, learners start transitive word combinations with these generic verbs. Thereafter, as Clark describes, "many uses of these verbs are replaced, as children get older, by more specific terms. . . . General purpose verbs, of course, continue to be used but become proportionately less frequent as children acquire more words for specific categories of actions" (p. 53). Notwithstanding the fact that prototypicality can help L2 learners during the beginning stages of acquisition of complex, graded and fuzzy concepts (such as tense-aspect meanings), the acquisition of the less prototypical exemplars of a complex concept remains an area of fertile research. This is particularly relevant in the case of target items that can only be concurrently defined at various levels of representation of language (e.g., lexical, morphosyntactic, discursive, and pragmatic at the same time). In the sections below, we address this issue through the specific analysis of specific tense-aspect meanings that could potentially be outside of the realm of the basic concept.

4.3.2. Redundancy

The Rescorla-Wagner model (1972) also summarizes how redundant cues tend not to be acquired. Not only are many grammatical meaning-form relationships low in salience, but they can also be redundant in the understanding of the meaning of an utterance. For example, it is often unnecessary to interpret inflections marking grammatical meanings such as tense because they are usually accompanied by adverbs that indicate the temporal reference. Second language learners' reliance upon adverbial over inflectional cues to tense has been extensively documented in longitudinal studies of naturalistic acquisition (Bardovi-Harlig 2000; Dietrich, Klein, and Noyau 1995), training experiments (Ellis 2007; Ellis and Sagarra 2010), and studies of L2 language processing (Van Patten 2006).

4.4. Contingency of form-function mapping

Psychological research into associative learning has long recognized that while frequency of form is important, so too is contingency of mapping (Shanks 1995). Consider how, in the learning of the category of birds, while eyes and wings are equally frequently experienced features in the exemplars, it is wings that are distinctive in differentiating birds from other animals. Wings are important features to learning the category of birds, because they are reliably associated with class membership, eyes are neither. Raw frequency of occurrence is less important than the contingency between cue and interpretation. Distinctiveness or reliability of form-function mapping is a driving force of all associative learning, to the degree that the field of its study has been known as 'contingency learning' since Rescorla (1968) showed that for classical conditioning, if one removed the contingency between the conditioned stimulus (CS) and the unconditioned (US), preserving the temporal pairing between CS and US but adding additional trials where the US appeared on its own, then animals did not develop a conditioned response to the CS. This result was a milestone in the development of learning theory because it implied that it was contingency, not temporal pairing, that generated conditioned responding. Contingency, and its associated aspects of predictive value, information gain, and statistical association, have been at the core of learning theory

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ever since. It is central in psycholinguistic theories of language acquisition too (Ellis 2006a, 2006b, 2008b; Gries and Wulff 2005; MacWhinney 1987b), with the most developed account for second language acquisition being that of the Competition model (MacWhinney 1987a, 1997, 2001). Ellis and Ferreira-Junior (2009b) use delta P and collostructional analysis measures (Gries and Stefanowitsch 2004; Stefanowitsch and Gries 2003) to investigate effects of form-function contingency upon L2 VAC acquisition. Boyd and Goldberg (Boyd and Goldberg 2009) use conditional probabilities to investigate contingency effects in VAC acquisition. This is still an active area of inquiry, and more research is required before we know which statistical measures of form-function contingency are more predictive of acquisition and processing.

4.5. The many aspects of frequency and their research consequences

Interference with any of these aspects reduces learnability: constructions of low salience of form are hard to learn, constructions where there is low reliability or contingency between form and meaning are hard to learn, constructions with subtle construals yet to be discerned are hard to learn, and constructions of low frequency of occurrence tend to be acquired later. Such findings suggest that the learning of linguistic constructions, like other concepts, can be understood according to psychological principles of category learning.

5. Applications of frequency-based grammar to the study of L2 tense-aspect

5.1. The Aspect Hypothesis

The study of tense-aspect has been a paradigm case in cognitive and functional SLA theory because of the pioneering work of such scholars as Roger Andersen, Yas Shirai, and Kathleen Bardovi-Harlig. Andersen was the first L2 researcher to pose the idea – following similar studies in L1 acquisition – that L2 language learners are initially influenced by the inherent semantic aspect of verbs in the acquisition of TA morphology affixed to these verbs. Andersen argued that L2 learners start out by using the perfective past morpheme with telic verbs (achievements and accomplishments, with a clear endpoint) before they extend its use to atelic verbs (activity and stative with no inherent end point). After the perfective form is established, learners start to mark states with the imperfective form and later spread its use to dynamic verbs towards telic events. Conversely, progressive marking is preferentially used with dynamic verbs (activities, accomplishments and achievements) and it is first used with activity verbs (atelic) before it spreads to telic verbs. That is, progressivity is preferentially marked first with verbs that focus our attention on the process rather than the end-state of the process.

This influence of the inherent lexical semantics of verbal predicates on the acquisition of morphosyntactic marking led to an important hypothesis of TA acquisition in terms of cognitive psychological processes of prototype formation (Andersen and Shirai 1994, 1996; Shirai and Andersen 1995). The *Aspect Hypothesis* (Andersen and Shirai 1994, see chapters 5 and 8, this volume) proposes that the abstract grammatical schema for perfective past generalizes from more concrete beginnings close to the prototypic centre in the clear exemplifications of telic achievements and accomplishments. Likewise abstract progressive morphology emerges from concrete exemplars in the semantics of activities and states.

Andersen's hypothesis was based on the analysis of L2 Spanish data collected among adolescent learners in the natural (non-classroom based) social environment of acquisition. Even though Andersen did not obtain data to confirm all stages of acquisition of past tense morphology, he proposed a sequence of acquisition of eight phases. The strong association of the lexical semantics of verbal predicates was predicted to occur during the initial four stages. Andersen argued further that the final four stages are necessary in the model to account for the fact that learners are eventually able to use both markers of past tense aspect with any lexical aspectual class, thus breaking the categorical pairing of one lexical aspectual class and one grammatical marker (e.g., states and Imperfect, achievements and Preterite). The last four stages point to the fact that the appropriate use of tense-aspect verbal endings brings about a level of discursive and semantic complexity that accounts for the difficulty L2 learners have in the process of acquisition. That is, a comprehensive account of how L2 learners approach the level of representation of tense-aspect meanings among native speakers must eventually go beyond the level of lexical aspect (cf., input frequency and prototypicality of meaning), incorporating in the process the variety of cues that underpin the more complex representations underpinning nativelike levels of grammatical aspect.

Aspect-before-tense phenomena also prevail in second language acquisition (Andersen and Shirai 1994; Bardovi-Harlig 2000; Indefrey and Gullberg 2008; Li and Shirai 2000). Adult language learners too are sensitive to the lexical aspects of verbs, initially using combinations of *lexical*

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and grammatical aspect that are maximally compatible, with telicity being a particularly salient feature. There is a substantial amount of empirical evidence offered in favor of the Aspect Hypothesis in SLA (e.g., Bardovi-Harlig 1998, 2000; Bardovi-Harlig and Reynolds 1995; Bergström 1995; Camps 2002, 2005; Collins 2002, 2004; Comajoan 2001, 2006; Hasbún 1995; Salaberry 1998; Shirai and Kurono 1998). who examined cloze passages, and Bardovi-Harlig (1998, 2000), who investigated oral production data obtained from narratives. Bardovi-Harlig (2000), in particular, presents an extensive functional analysis of the acquisition of L2 TA morphology in terms of cognitive principles and semantic prototypes. Thus L2 learners from a wide variety of L1/L2 combinations first use perfective past marking on achievements and accomplishments, and only later extend this to activities and state. Similarly, in L2s that have progressive aspect, progressive marking begins with activities and only extend slowly thereafter to accomplishments and achievements.

Despite this support for the LAH, the original argument about the effect of the inherent lexical semantics of the verbal predicate on the morphosyntactic marking of tense-aspect was underspecified with regards the timing of this effect: Does lexical aspect guide the process from the beginning stages of acquisition and later subside as learners are able to use both grammatical markers with every verb type as the LAH suggests? Or, does the effect of lexical aspect increase with experience in the L2? Previous researchers have not been clear on this point. Robison (1990) argued that the effect of lexical aspect occurs "*when L2 verb morphemes enter the interlanguage* of an adult language learner," but also that ". . . verbal morphology correlates with lexical aspect at least *during some stage during the development of an interlanguage*" (Robison 1990: 329–330, italics added).

Wiberg (1996) and Salaberry (1999) argued for an expansion of the claim made by Bergström showing that the perfective form was used with all lexical aspectual classes (not just dynamic verbs) during the very beginning stages of acquisition. Again, these results do not reject the effect of a past tense prototypical marker; quite the opposite. Nevertheless, the effect of straight lexical-grammatical pairings is weaker than expected by the LAH. Also, more recent studies have shown that the effect of lexical aspect tends to increase with exposure to the L2. This is contrary to the expectation that lexical semantics has maximum effect at first until non-prototypical pairings are eventually incorporated to the L2 system. In fact, even early proponents of the LAH have acknowledged the replication of findings that demonstrate the increasing rather than decreasing effect of prototypical tense-aspect markings. Thus, Shirai (2004, p. 103) states that at least in some contexts

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"in cross-sectional studies involving production data, the prototypical association becomes *stronger* as the learner's proficiency increases". These results are in agreement with the importance of type and token frequency; that is, the productivity of a pattern is a function of type frequency; the more forms that exemplify a pattern, the more productive that pattern becomes (see section 4.1.2.)

Perhaps the strongest evidence in favor of the increasing association of grammatical marking of tense-aspect and lexical aspectual classes as learners acquire more experience in the L2 is provided by Salaberry (2011) with a study that compared the claims of the LAH and the Discourse Hypothesis (DH). The findings are important because this study used a large number of participants, thus providing a more robust data set than is normally used in tense-aspect studies. The results showed both that L2 learners increased their use of past tense markers in association with the inherent lexical meanings of verb phrase, and, more importantly, that native speakers had the highest association of prototypical pairings in their use. Thus, L2 learners seem to be converging, in asymptotic terms, towards the native speaker norm. That is, the main factor behind this change seems to be the distributional bias present in native speakers' choices, which is clearly related to exposure and frequency of data. Obviously, as L2 learners gain more experience in the language and have more exposure to language samples, they are able to converge more and more towards the native speaker standard.

A frequency-based approach argues that frequency/prototypicality effects are there from the very get-go, because they determine the sample of language which a learner is likely to experience. Zipf's law entails that particular exemplars are very high frequency – these are the ones a learner is going to experience first, and these are the ones that therefore seed the system. If, as is typical in language, the high frequency forms in a construction are also prototypical in meaning, then these are the ones a learner will sample (section 4.1.3 and 4.3.1). These results are in line with other studies that have investigated the influence of input frequency on TA acquisition in L1 (Shirai, Slobin, and Weist 1998) and L2 (Andersen 1990). More specifically, Andersen (1990, The Distributional Bias Hypothesis) observed that the input available to learners exhibits distributional patterns similar to those observed in learners' productions: "Native speakers in interaction with other native speakers tend to use each verb morpheme with a specific class of verbs, also following the aspect hypothesis" (Andersen and Shirai 1994, p. 137). Such input frequency biases should aid the statistical learning of TA constructions.

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5.2. The effect of frequency-based constructionist biases on the acquisition of L2 aspect

Wulff, Ellis, Römer, Bardovi-Harlig, and LeBlanc (2009) analyzed the effect of the constructionist principles outlined in section 4 (input frequency, prototypicality of meaning, and contingency of form-function mapping) for learning tense-aspect meanings using corpus linguistic analyses of representative samples of language input and of learner language. The study was designed to test frequency-based constructionist hypotheses for the acquisition of English L2 TA constructions as cognitive categories. The particular hypotheses used in this study, and the findings relating to them, were as follows:

> H1: Natural language data has a distributional bias whereby some verb types occupy each TA construction much more frequently than others, the distribution of the types constituting each construction being Zipfian.

In order to examine frequency biases in the input, we retrieved verb form frequencies for all verbs from two native speaker corpora taken to represent the type of language input adult second language learners are exposed to: the 10 million word spoken section of the British National Corpus (BNC_{spoken}) and the 1.7 million word Michigan Corpus of Academic Spoken English (MICASE, Simpson, Briggs, Ovens, and Swales 2002). All verb form frequencies were retrieved from CLAWS-tagged versions of BNC_{spoken} and MICASE, respectively. When we analyzed the verbs tagged as simple past or progressive, their frequency distributions across the different TA categories was Zipfian: the frequency with which verbs occur with a certain tense-aspect category is inversely proportional to their rank in the frequency table, with the most frequent verb types accounting for the lion's share of all occurrences of any given TA morpheme. Unlike for the VAC data in Ellis and Ferreira-Junior (2009a,b) however, the top ten most frequent verbs within each category were not typically distinctive of that category, because the very highest frequency verbs in the language (like *do*, *be*, *have*, and *get*) naturally occupy the top ranks across all TA categories.

> H2: More-frequent verbs in each TA construction are distinctively associated with that construction in the input.

In order to determine which verbs are particularly associated with the progressive and the perfective more systematically we computed form-meaning contingencies (see section 4.4), in this case using a multiple distinctive collexeme analysis (MDCA) for the BNCspoken and MICASE data sets (Gries and Stefanowitsch 2004). The association-based distributions showed that a small number of verbs are extremely highly associated with a particular TA category, and association strength drops exponentially thereafter. Ranking the top ten most distinctively associated verbs for each TA reflected intuitions about verbs that typically occur with the different TA categories: the past and perfect TA columns were occupied by highly telic verbs such as *die*, *crash*, *explode*, *lose*, or *finish*; the progressive preferred continuous action verbs like *sit*, *play*, *walk*, and *run*. These distinctively-associated verbs, while not *the* highest frequency in the language (H 1), are frequently experienced in that construction.

> H3: The verbs most distinctively associated with each TA construction in the input are prototypical of the meaning of that construction.

In order to investigate the prototypicality of the verbs, we obtained native speaker telicity ratings for a range of verbs selected from these analyses from 20 native speakers of American English. A questionnaire presented the verbs in isolation, without arguments, and in their base forms. Subjects were instructed to evaluate each verb with regard to how strongly it implies an endpoint expressed in values from 1 (if there is no endpoint implied) to 7 (if an endpoint is strongly implied). Three examples were given: *smash* as a highly telic verb, *continue* as an example of a verb that is located at the opposite, atelic end of the continuum, and *swim* as an example of a verb that falls somewhere in between.

The resulting Telicity Rating data demonstrated that those verbs distinctively associated with past tense in the input received significantly higher telicity ratings than verbs associated with the progressive (MICASE data: $t = -2.107$; df = 18; $p = .049$; BNC spoken data: $t = -4.356$; df = 18; $p < .001$).

> H4: The first-learned verbs in each TA construction are prototypical of that construction's functional interpretation in terms of their telicity / lexical aspect.

Wulff et al. analyzed oral production data collected by Bardovi-Harlig (2000) who had 37 English beginning L2 learners from 5 different L1 backgrounds watch an excerpt of *Modern Times* and then tell the story in their own words. The resulting narratives produced an average of 51 verb tokens. All verb forms were coded for TA morphology (that is, simple past, past progressive, pluperfect, present, present progressive, progressive without auxiliaries, present perfect, or "uninterpretable"). For the purpose of their study, Wulff et al. selected from this data set verbs that occurred more than 10 times overall and which were distinctly associated with present, simple past, or progressive as determined by a chi-square test. The 5 most frequently occurring past tense verbs in the learner production data (*say*, *see*, *steal*, *take*, *tell*) and the 5 most frequently occurring progressive verbs (*begin*, *eat*, *run*, *think*, *walk*) differed significantly in their mean telicity ratings ($t = -2.838$; $df = 9$; $p < .01$), with the past tense verbs being judged more telic and the progressive verbs more atelic.

In sum, the results of Wulff, et al suggested that the verbs first learned by adults in the progressive are also frequent in the progressive in the input, distinctively associated with the progressive in the input, and highly atelic (i.e., significantly less telic than verbs frequent and associated with past tense in the input). Likewise, the verbs first learned in past tense are frequent in past tense in the input, highly distinctive for past tense in the input, and highly telic. These findings provide some support for the hypothesis that the learning of tense and aspect, like that of other linguistic constructions, can be understood according to psychological principles of category learning. In terms of the frequency-based associative, cognitive, and functional properties of TA construction learning: (1) The first-learned verbs in each TA construction are those which appear frequently in that construction in the input. (2) The first-learned pathbreaking verbs for each TA construction are distinctive of that construction – the contingency of forms and function is reliable. (3) The first-learned verbs in each TA construction are those which are prototypical of the construction's functional interpretation in terms of telicity / lexical aspect. TA construction learning is sensitive to input frequency, reliabilities of form-function mapping, and prototypicality of lexical aspect in English.

Although the analyses of spoken language carried out by Wulff et al. (2009) involved quite extensive corpus analysis, it is a stretch to claim that the language sampled therein was properly representative of that to which the ESL learners had been exposed. Additionally, the learner data was small, far from dense, and it covered only a very short period of initial acquisition. Finally, the study focused on L2 English only as the target language. We turn next to the analysis of more advanced levels of L2 Spanish, a language with a complex representation of tense-aspect markers to investigate the effect of input frequency, prototypicality and the mappings of form and meaning.

5.3. The effect of frequency-based constructionist biases on acquisition of Spanish L2 aspect

The effects described for English above are, by and large, also relevant for the analysis of L2 Spanish data. However, the analysis of more advanced Spanish data to be discussed below (from Salaberry 2011) brings about a challenge for any constructionist approach operating only at a lexical level: the distinction between the aspectual concepts of iterativity and habituality as shown in sentences (1a) and (1b).

(1a) *Cuando era niño, Lucas jugaba al fútbol.* [habitual]
When [he] was a child, Lucas played/used to/would (IMP) play soccer.

(1b) *Por años, Lucas jugó al fútbol.* [iterative]
For years, Lucas played (PRET) soccer.

The main challenge for learners is that the use of the perfective form to make reference to extended events in the past is predicated on the facts that iterativity (i) is not very frequent in the input, and (ii) it does not represent a prototypical marker of iteration (i.e., the imperfective form is the prototypical marker, as documented in one of the most traditional and used rules taught to Spanish learners). On the other hand, learners can benefit from the fact that the grammatical marking of iterated events provides a direct mapping of form and function (i.e., iterativity is always marked with the Preterite, whereas habituality is marked with the Imperfect). That is, L2 learners need to go beyond the realm of prototypical pairings of lexical aspect and grammatical markings to learn some specific aspectual meanings that are clearly marked in Spanish through the choice of perfective or imperfective marker. To do so, however, L2 learners must take into account broader pieces of discourse than it would be required to make decisions about straightforward lexical-grammatical pairings (as discussed in the analysis of English data above).

If the challenge is to process ever-longer pieces of discourse to make judgments on the aspectual representation of eventualities, one of the first, most immediate elements that has to be considered to mark aspectual contrasts is the role of adverbial phrases. For instance, Menéndez-Benito (2001) shows how adverbial phrases can change the prototypical meaning of the perfective marker in Spanish (i.e., episodic meanings) to represent the iteration of eventualities (i.e., an aspectual concept reserved for the imperfective marker). The difficulty brought about by the broader discourse prompted by the computation of adverbials (on top of the analysis of external and internal arguments) for the marking of iterated eventualities is corroborated by the few studies that have looked at this area of studies. Previous studies (e.g., Pérez-Leroux et al 2007; Salaberry and Martins 2011; Slabakova and Montrul 2007) show, categorically, that L2 learners – even highly advanced learners – fail to recognize the aspectual meaning of iterativity (conveyed through the use of the Preterite) as distinct from the meaning of habituality (conveyed through the use of the Imperfect).

A constructionist explanation that the use of the Spanish Preterite to express iterativity is difficult for L2 learners to acquire would first point to the facts that iterative meanings of the Preterite are neither frequent in the input nor prototypical of the perfective form. A richer analysis of the problem is, nevertheless, possible given that the focus of Construction Grammar is as much about constructions above the word level (e.g., grounding information) as about lexical or morphological units (e.g., lexico-semantic information), thus we assign a prominent role to the conspiracy of cues in processing (see section 4.1.3 and the acquisition of Verb-argument constructions). In this respect, native speakers systematically use cues provided by adverbial phrases to select the use of Preterite or Imperfect to mark either iterativity or habituality. The debate is whether we can correlate the use of Preterite and Imperfect with generic and durational adverbial phrases as proposed by Menéndez-Benito, or specific adverbial phrase constructions as proposed by Salaberry and Martins, or some other alternative option. Further research needs to investigate how the lexical-level cues act in combination with adverbial phrases, and how learners may be more sensitive to some cues (lexical or discourse-building) in this conspiracy at different stages of language acquisition (Salaberry 2008, 2011, Rosi 2010).

6. Conclusions and Future Research Directions

The first part of this chapter gathered a range of frequency-related factors that influence the acquisition of any linguistic constructions:

1. the frequency, the frequency distribution, and the salience of the form types,
2. the frequency, the frequency distribution, the prototypicality and generality of the semantic types, their importance in interpreting the overall construction,
3. the reliabilities of the mapping between 1 and 2, and
4. the degree to which the different elements in the construction are mutually informative and form predictable chunks.

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The second part applied these factors to TA acquisition. Before learners can recognize or use TA constructions productively, they have to analyze them, to identify their linguistic form and then map it to meaning. Each construction has its own form, meaning, and corresponding mapping pattern. Research shows that the input that learners get is biased so that they experience past tense forms predominantly with verbs which are distinctively associated with more telic construals, and progressive forms predominantly with verbs which are distinctively associated with more atelic construals. Language lines up with the world, or, better, with the way we construe it. Our understanding of the world lines up with our language. Our actions in the world, our categorization of the world, and our talk about these actions and classifications occur in broadly parallel relative frequencies. Such parallels make constructions learnable.

There are many factors involved, and research to date has tended to look at each hypothesis by hypothesis, variable by variable, one at a time. But they interact. And what we really want is a model of usage and its effects upon acquisition. We can measure these factors individually. But such counts are vague indicators of how the demands of human interaction affect the content and ongoing co-adaptation of discourse, how this is perceived and interpreted, how usage episodes are assimilated into the learner's system, and how the system reacts accordingly (see Bayley; Giacalone-Ramat and Rastelli; Salaberry, Comajoan and González, this volume).

Usage is rich in latent linguistic structure, thus frequencies of usage count in the emergence of linguistic constructions. Corpus Linguistics provides the proper empirical means whereby language input can be counted. But this is not enough; we also require an understanding of the psychology of cognition, learning, attention, and development. Sensation is not perception, and the psychophysical relations mapping physical onto psychological scales are complex. The world of conscious experience is not the world itself but a construal crucially determined by attentional limitations, prior knowledge, embodiment and context. Not every experience is equal – effects of practice are greatest at early stages but eventually reach asymptote. The associative learning of constructions as form-meaning pairs is affected by: factors relating to the form such as frequency and salience; factors relating to the interpretation such as significance in the comprehension of the overall utterance, prototypicality, generality, and redundancy; factors relating to the contingency of form and function; and factors relating to learner attention, such as automaticity, transfer, and blocking.

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Univariate counts are vague indicators of how the demands of human interaction affect the content and ongoing co-adaptation of discourse, how this is perceived and interpreted, how usage episodes are assimilated into the learner's system, and how the linguistic system reacts accordingly. We need models of learning, language, meaning, usage, interaction, development, and emergence that take all these factors into account dynamically. Some progress on language and meaning comes from cognitive linguistics (Robinson and Ellis 2008), though this is often non-quantitative research. Some progress on language usage comes from corpus linguistics (Gries and Divjak, in press), though all too often this is cognition-light. Some progress on interaction comes from work on the interaction hypothesis (Mackey and Gass 2006), though too often this is language-light. Some progress on emergence is being made in emergentism and complexity theory (Ellis 1998; Ellis and Larsen Freeman 2006a; Ellis and Larsen-Freeman 2009b; Elman, et al. 1996; Larsen-Freeman 1997; Larsen-Freeman and Cameron 2008; MacWhinney 1999) which analyzes how complex patterns emerge from the interactions of many agents, how each emergent level cannot come into being except by involving the levels that lie below it, and how at each higher level there are new and emergent kinds of relatedness not found below. These approaches align well with dynamic system theory, which considers how cognitive, social and environmental factors are in continuous interactions, where flux and individual variation abound, and where cause-effect relationships are non-linear, multivariate and interactive in time (de Bot, Lowie, and Verspoor 2007; Ellis 2008a; Ellis and Larsen Freeman 2006a, 2006b; Port and Van Gelder 1995; Spencer, Thomas, and McClelland 2009; Spivey 2006; van Geert 1991). But research in emergence and DST are often light in the details of the component parts.

Recent developments in corpus linguistics, NLP, and computer simulation suggest that a tractable approach is to combine the qualitative linguistic analyses of construction grammar and corpus linguistics as applied to longitudinal corpora of learner language and large samples of representative input. These can then to be brought together in quantitative computer simulations of construction acquisition (Christiansen and Chater 2001), either connectionist, agent-based, or exemplar-driven, illustrated, for example, in the initial explorations of MacWhinney and Leinbach (1991), Ellis and Schmidt (1998), Li and Shirai (2000), and Ellis with Larsen-Freeman (2009a). Even then, much will remain to be done in building into such models more sophisticated representation of salience of form and its perception, meaning and embodiment, and learner attention.

The analyses of the psychological representation of tense-aspect meanings, the linguistic means by which these representations are explicitly conveyed in usage, and their developmental sequences in interlanguage together provide a rich testing-ground for investigation of cognitive and linguistic universals of tense-aspect and of the role of frequency-tuning in the usage-based abstraction of constructions as categories.

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