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Current Trends and Emerging Methodologies in Charting Heritage Language Bilingual Grammars*

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The field of heritage language (HL) acquisition has emerged in earnest over the past two decades as part of a wave of expansion in investigating bilingual language scenarios beyond the two previously widely studied cases: (i) simultaneous child bilingual (2L1) development and (ii) non-native adult second language (L2) acquisition. Whereas 2L1 development tends to follow qualitatively similar paths and developmental milestones to monolingual children (see e.g., de Houwer, 1990; Meisel, 2011; Serratrice, 2013; Kupisch, 2006 for review), adult L2 learners are often significantly different in developmental sequencing and outcomes (see White 2003; Ortega, 2014; Slabakova, 2016 for review). This juxtaposition seemed to offer solid argumentation in favor of the Critical Period Hypothesis' (CPH) (Lenneberg, 1967) application to adult bilingual language learning.¹ Must such differences mean that age is deterministic for one's potential to employ domain-specific mechanisms for acquiring language in a truly native manner? Most relevant for the present handbook, how can the study of heritage speaker (HS) bilinguals help adjudicate between the various positions argued on the basis of the above juxtaposition?

Definitive claims based on the above observations suffered in the 1980s and 1990s from a lack of data from other populations, arguably needed to understand the overall picture.

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¹See du Plessis, Solin, Travi and White (1987) and Schwartz (1992) for early on argumentation related to concerns with using comparative developmental sequencing data to make such claims.

Child L2 acquirers,² L1 attriters,³ and especially adult HS bilinguals were studied in increasing numbers starting in the mid 1990s, changing what we now see as a much wider picture. The developmental trajectories and outcomes of these then understudied populations had something relevant to contribute to the CPH debate in adult bilingualism. For example, if asymmetries in developmental sequencing or outcome differences from monolingual baselines indicate a fundamental difference between child and adult acquisition, then, distinctly from what is expected of adult L2 learners, one would predict child L2 acquisition to approximate somewhat faithfully child L1 development; and early native bilingual speakers to wind up with grammars falling within the range of monolingual variation. As it turns out, neither of these predictions obtain straightforwardly. Child L2 acquisition shows very similar degrees of transfer as adult L2 acquisition, whereby developmental trajectories are distinct from monolingual children even if, on average, ultimate attainment is more convergent in the case of L2 children (see Gavrusseva & Haznedar, 2008; Haznedar, 2013 for review). HS bilinguals tested in early adulthood, despite being naturalistic L1 or 2L1 native speakers of their home language (Rothman & Treffers-Daller, 2014), present competencies and performances⁴ across a wide spectrum of differences as compared to monolingual natives (see Polinsky, 2018 for review). Both of these facts challenge the claim that similar differences seen in adult L2 acquisition must be taken as evidence for a fundamental difference in mechanisms between children and adults for language learning overall. Apparently, early exposure before puberty does not guarantee a monolingual-like path or outcomes.

² Sequential learners of a second language in early childhood after an L1 is established but not yet completely acquired (see e.g. Haznedar, 2013)

³ Native speaker individuals, typically immigrants, who experience significant shift in exposure to and opportunities for use of their L1, resulting in changes in competence and/or ways in which they process their L1 (see e.g. Schmid & Köpke, 2017),

⁴ By competence and performance, we refer to the distinction between one's underlying system of the mental representation of grammar versus the way in which this knowledge system is used. The latter can be affected by memory limitations, attention and other filtering issues (e.g., Chomsky, 1964).

As Polinsky and Scontras (2020:2) put it, “*heritage speakers constitute an outcome often assumed to be impossible outside of pathology or trauma: children exposed to a language from birth who nevertheless appear to deviate from the expected native-like mastery in pronounced and principled ways.*” Understanding how and why heritage grammars develop the way they do, inclusive of what variables predict outcomes at the individual level, can offer profound insights for linguistic theory in general (e.g., Scontras, Fuchs & Polinsky, 2015; Lohndal, Rothman, Kupisch & Westergaard, 2019) as well as for challenges related to language maintenance, contact, policy and more (e.g., Suarez, 2002; Valdés 2005; Brinton, Kagan, & Bauckus, 2017). However, capturing what HSs actually know about (one of) their native grammar(s) is especially challenging for various reasons (see Polinsky, 2018 for comprehensive review) related to their experiences with their HL, how we test such knowledge and the interface of the two.

HSs are typically not trained, literate readers of their HL. For many HSs, the language is imparted and used almost exclusively orally. Thus, even in the case the HL and the majority language share the same script and overlap in phoneme-to-grapheme correspondence, HSs are likely to be slower in reading the HL. HSs experience, on a continuum, reduced quantities of input as well as contexts in which they are likely to hear/use the HL. This reality, in turn, affects knowledge of particular vocabularies and discourse conventions pertaining to distinct registers. These facts, of course, bring much to bear on the appropriateness of particular experimental designs/choices, depending on the questions one seeks to address. In general, tasks that assume some level of literacy competence/experience, specific vocabulary knowledge and/or are likely to hinge to some degree upon metalinguistic training that formal education imparts are best avoided. Moreover, HSs can simply be reluctant or anxious for a multitude of reasons to offer definitive judgments on their HL (Polinsky, 2016). As a result, some tasks widely used with other sets of speakers such as

Grammaticality Judgement Tasks and Acceptability Judgement Tasks are either best to avoid or need to be modified with the above in mind.

Depending on the research question, for example, seeking to tap the status of a morphosyntactic or phonological representation in the HS mental grammar becomes more appropriate than testing whether or not, and if so under what conditions, HSs produce morphosyntactic reflexes or phonological exponents. Consequently, methodologies that probe comprehension offline and related on-line processing reflexes (e.g. prediction/facilitation) versus production come to the fore. Comprehending/processing (some of) the manifold implications of functional morphology and/or perceiving phonological contrasts that are not consistently produced, if at all, by the HSs offers insight into competence that would go unnoticed via production alone. For example, if a HS of Cantonese has apparent issues in the production of lexical tones but shows via perception experimentation that such differences are more quantitative than qualitative in nature (Lam, 2018), such experimentation reveals knowledge that is not easy to intuit from her use of the language.

At the end of the day, we seek to understand HL grammars fully, which entails studying both comprehension and production and, more to the point, reconciling what we take the relationship between the two to be. We know from the rather limited work on receptive or passive heritage bilinguals—heritage bilinguals that seemingly have much greater comprehension skills in the HL than production abilities—that production can lag far behind the ability to understand the HL (e.g. Sherkina-Lieber 2015; Holmes, 2017). There is clearly not a one-to-one relationship between comprehension and production abilities. The exact relationship between the two and how they inform each other are a matter of perspective, if not debate; however, what is uncontroversial is that they both relate to an underlying language system. Although in dominant native speakers, comprehension and

production have much greater overlap, studying HSs reminds us that while both relate to each other and to a common source of mental competence, they are distinct and diverge in their involvement/dependence on other mechanisms. Various traditions of linguistics place more or less emphasis on the two: experimental acquisitionists and psycholinguists tend to be more interested in comprehension/perception whereas sociolinguists and more applied linguists have a greater tendency to focus on production, especially what conditions the production of language in various contexts. Comprehension/perception and related processing in real time experimentation might offer the most straightforward glimpses into more automatic underlying processes. Production, alternatively, offers greater, more ecologically valid insights into how the HL is used in sociolinguistic patterns and/or can be exploited as a path to capturing the status of the underlying mental grammar.

Given that it is not clear what can be concluded based on testing HSs in the “traditional” ways used with subjects trained in the target language, be it an L1 or L2, experimentation that is able to neutralize or circumvent the above challenges is especially welcome and on the rise. In this chapter, we take stock of where we are at methodologically. We place a special emphasis on newer methods to the domain of HL bilingualism that we believe are particularly suited to uncover the underlying basis of individual differences in HS outcomes as well as on methods that capture more automatic indexes of processing.

2. Offline studies

To date, most studies interested in tapping the nature of HL competence have used offline methods, for example, acceptability judgment tasks, comprehension tasks, production (elicitation tasks and natural corpora) and recognition tasks (e.g., Silva-Corvalán, 2014; Montrul, 2002, 2011; Montrul, Foote, & Perpiñán, 2008; Pascual y Cabo, 2018; Polinsky 2008, 2011; Pires & Rothman, 2009; Rothman, 2007; Johannessen, 2018; Hopp, Putnam &

Vosburg, 2018; Lloyd-Smith, Gyllstad, Kupisch & Quaglia, 2018; Isurin & Ivanova-Sullivan, 2008; Lohndal & Westergaard, 2016; Bayram et al. 2017; Lee-Ellis, 2011; Kim, O’Grady & Schwartz, 2018). By their nature, offline tasks do not offer direct access to one’s mental processes as they unfold in real time. They are an outcome measure of the linguistic and/or cognitive processes that took place before a production, judgement or comprehension index is recorded, together with (potentially) conscious, metalinguistic knowledge. Having a look at how grammatical gender has been typically studied in HL affords us the opportunity to examine a range of typical offline experimental tasks. We thus turn to this property now as an exemplar.

It is well established that in languages where it is a grammatical category, gender is an inherent lexical feature on nouns (Corbett, 1991) while determiners and adjectives may exhibit gender agreement with the head noun. The former constitutes lexical knowledge, i.e., one-to-one for each noun, while the latter, gender as expressed via systematic agreement within noun phrases (e.g., on determiners and adjectives), does not require one-to-one learning and constitutes syntactic knowledge.⁵ A clever experimental paradigm to tap knowledge of the gender system has been used to examine the status of gender agreement within the determiner phrase without the appearance/suppliance of the lexical noun itself. Nominal ellipsis, noun-drop in Spanish, *la roja* ‘the red [one]’, is the example. The identification of the missing noun in context crucially depends on the gender and number valuation of the elided noun in the mental lexicon. And so, examining noun-drop gives one simultaneously insight into the gender assignment for specific lexical items as well as one’s ability to use the morphosyntactic agreement cues in real time comprehension. In a well-known study following White et al. (2004), Montrul, Foote and Perpiñán (2008) used a noun-

⁵ We do not mean to suggest that gender is literally learned in a one-to-one manner for each word for all speakers of all languages. The need for doing so depends on the relative transparency of the system, for example, we might expect differences between Spanish, which has highly transparent patterns, and Dutch, which is highly opaque, regardless of the type of learner.

drop task to compare knowledge of gender agreement in the performance of Spanish L2 learners and HSs, ranging from low to advanced levels of proficiency. L2 speakers showed an advantage over HSs for this particular task (90% versus 80%). Montrul, Foote and Perpiñán's participants were given a choice of three common objects in three pictures. In one experimental item, the three pictures showed a suitcase, a book, and a pair of socks. The stimulus sentence was *María contesta: "Sí, claro, va a hacer mucho sol. Ponlas ahí cerca de la roja."* (Maria answers: "Yes, of course, it is going to be very sunny. Put them over there by the red [one]"). The phrase *la roja* points to a missing nominal, which is feminine and singular, as indicated by the determiner *la* and the morphological ending in the adjective *roja*. If learners compute gender agreement, they can use it to pick the picture of the suitcase (*la maleta*), whose gender is feminine. The book (*el libro*) should not be selected, since it is masculine. The third picture contains a foil (*los calcetines*) which is masculine and plural. Participants are engaged in a puzzle-like task, and their comprehension rather than production indicates whether abstract features are functional in their grammars.

Generally speaking, how do we know whether HSs have monolingual-like gender assignment, i.e., have the same gender class assignment for each noun compared to native monolinguals? How much emphasis should we even be placing on gender assignment "correctness" if agreement is our real object of inquiry? These are crucial questions if one wishes to shed light on the status of the HL syntax of gender, precisely because it manifests as an agreement system dependent on the lexical assignment of the nouns, even if "wrong." One potential contributor for divergence noted in work like Montrul, Foote and Perpiñán above could have as much or more to do with HL differences in gender assignment at the lexical level than be indicative of anything askew in the HL syntactic agreement system. Such a possibility gains credence in light of later work by Hopp (2013), which highlights the inherent nature between lexical and syntactic variability in this domain, and recent eye-

tracking work by Fuchs (2019), showing that when one corrects for assignment, HSs of Spanish show the exact same qualitative patterns in processing gender and using it facilitatively. Hopp's work calls for a leveling of the playing field (so to speak) when comparing monolinguals to bilinguals of all sorts: agreement should be evaluated in direct proportion to the lexical assignment an individual has for the set of nouns used in experimentation. In other words, if a noun is demonstrated to be feminine in the mental grammar of HS X, whether or not it is in other speakers' grammars, then agreement is evaluated as correct on the basis of what X's assignment is established to be. Of course, we are also interested in understanding how and why individual HSs might wind up with distinct lexical gender assignments, but that is a different question, one of learning, as opposed to our main question that seeks to uncover the status of the mental representation of gender as an operative functional category in HL grammars.

Other offline tasks abound in the literature. For example, Polinsky (2008) tested Russian heritage speakers' knowledge of gender categorization. In two experiments, she combined nouns with well-known adjectives and possessive pronouns. The participants' task was to produce a phrase with the adjective *bol'sh*- 'big' or the pronoun *tv*- 'your' after hearing each noun. In a second experiment, participants heard recordings of congruent and incongruent combinations of the same adjectives with various nouns, and had to indicate whether the combination was acceptable. The findings allowed the researcher to conclude that half of her participants had a two-gender system instead of a three-gender one, as in baseline monolingual Russian. Such exemplary work allows for documenting and understanding the systematic nature of HL systems, in this case gender, even when they are distinct from the monolingual baseline. Polinsky (2008) thus demonstrates that HL Russian in the US is distinct from monolingual Russian, but in a way that shows an intact gender system in its own right, albeit one that deviates from the standard variety.

Undoubtedly, chapters in this handbook will have looked into offline methods in much greater detail. The remit of this chapter is not to delve into the details of such research, but to highlight three points relevant for our assigned task of discussing and encouraging innovation in HL research methodologies: (a) establish what has been done in an effort to (b) highlight the inherent methodological challenges in order to (c) promote research methods that circumvent these challenges. With notable exceptions we will discuss in detail below, experimental tasks to date have tended to range from more metalinguistic, classroom-style tasks such as forced choice of morphological endings or free morphemes, through oral picture description tasks to written comprehension tasks such as the White et al.'s (2004) noun-drop experiment adopted to HL Spanish in Montrul, Foote and Perpiñán (2008) described above. There is relative consensus (Montrul, 2015) that experimental tasks and groups (HSs and L2ers) interact in this type of research. L2 learners typically perform better than HSs in highly metalinguistic written tasks. On the other hand, HSs perform more monolingual-like than L2 learners in oral production tasks and in phonology discrimination tasks (Au, Knightly, Jun, & Oh, 2002). In sum, offline methods of studying HL have closely replicated those used in L2 acquisition research, both because the experiments are known to be tried and true from decades of use and for the purposes of comparing these two populations. The variety of tasks have uncovered both similarities and significant distinctions between HL development/outcomes and those of typical adult L2 learners (Montrul, 2008, 2012).

While HL studies as a cohort have documented time and again differences from the expected baselines of monolinguals, the field has yet to uncover with the same precision and replication what variables prove predictive (related to input exposure, patterns of use and more) to path and outcome, at the group or individual level (see Polinsky and Scontras, 2020 for steps in this direction). Moreover, a critical mass of research on HL processing is not yet

available to meaningfully test if there is a convergence between offline and online data in general, much less fully understand the consequences of what it would mean to show qualitatively more convergent processing by the same HS participants that can diverge so much in offline task performances. We do not yet have the data needed to fully chart heritage language development to see, longitudinally or via carefully constructed cross-sections, what the dynamic course of development and maintenance of HLs are over the lifespan, despite compelling reasons to believe that a lot would be gained by focusing on filling these gaps. As Scontras, Fuchs and Polinsky (2015) note: “[w]hile these practices necessitate a good deal of time and care on the part of the researcher, we have seen that they pay off, both by answering the specific questions targeted by the given study, and by raising additional questions central to any theory of grammar.” In the remainder of this chapter, we focus on research that attempts to fill the above gaps, since we see these as integral to the future of HL studies on HS competence.

3. Online research methods

3.1 Why do we need online methods in HL studies?

As established above, offline measures seeking to tap HS competence represent, by far, the largest portion of available data sets. While this literature has produced a wealth of high-quality research and knowledge, there are at least two important issues related to the use of offline methods that can affect conclusions drawn almost exclusively from them: (i) the kind of knowledge that they require from participants and (ii) the granularity and purity of what is (sometimes) captured by offline performances alone.

In untimed offline tasks, participants have the space to think before they offer an answer. This can mean that metalinguistic consciousness and potentially other affective factors become difficult to tease apart from underlying competence, only the former being the actual object of inquiry in the relevant HL literature. Whether formally trained in their HL or

not, HSs are likely to have various types of explicit knowledge related to their HL (either specifically learned or what they have deduced themselves) and regarding language in general. Conscious explicit knowledge in the case of HSs is, potentially, distinct from what educated dominant-native speakers have. HSs often have the impression that their knowledge and use of the HL is prescriptively “wrong”, often viewed negatively by themselves and by various members of their communities. How does this affect how they perform on offline tasks? Do (all) offline methods (equally) ensure that such factors (and other potential noise) do not obscure ensuing data? Unlike dominant-native speakers of the same language, HSs typically do not have the same common formal experiences with their home language such as schooling in the standard variety. What is the effect of this in offline tasks (Rothman, 2009; Bayram et al., 2017)? Both native-dominant L1 and adult L2 speakers are exposed to the formal standard variety in school settings and purposefully develop literacy and metalinguistic skills in that language. Recall that many HSs have little or no literacy experience in their L1, at least until adult age if they endeavor to re-learn their heritage language in a formal setting (Polinsky & Kagan, 2007; Polinsky, 2015). HSs are well-known to be conservative in judgement tasks (effectively not using the absolute ends of Likert scales, for example, Polinsky, 2018). This is potentially, at least in part, due to the formality of being tested in a language they are (typically) not dominant or balanced in and has not been the language in which they would have done other types of testing throughout childhood and adolescence. As discussed in the introduction, specific tasks requiring or easily impacted by any experience-based and affective factors are not ideal, on their own, to study HLs and their speakers (Bolger & Zapata, 2011; Polinsky, 2018).

Without doubt, there are very carefully designed studies tapping into HL comprehension that are not easily affected by the above factors and/or production-based work showing clear patterns of underlying HL competence. However, efforts in recent years to

assess HL knowledge while bypassing some of the above concerns have turned the field more and more to online research methods, such as self-paced reading tasks, masked priming tasks, eye-tracking, and the electroencephalography (EEG) methodology (e.g., *self-paced reading task*: Foote, 2011; Jegerski, 2018a, 2018b; Keating, Jegerski, & VanPatten, 2016; Puig-Mayenco, et al., 2018; Villegas, 2018; *eye-tracking*: Arslan, Bastiaanse, & Felser, 2015; Jegerski & Sekerina, 2019; Sekerina & Sauermann, 2015; Sekerina & Trueswell, 2011; van Rijswijk, Muntendam & Dijkstra, 2017; Villegas, 2014; *masked priming task*: Jacob & Kırkıcı, 2016; Jacob, Şafak, Demir & Kırkıcı, 2019; *EEG methodology*: Martohardjono, Phillips, Madsen & Schwartz, 2017; van Rijswijk, 2016).

Online tasks measure participants' automatic responses to language stimuli, giving us a more direct access to *how* language processing unfolds in real time. To be fair, all measures, offline and online alike, record types of performances and are, thus, subject to extraneous, interceding factors. Each, albeit differentially, tap into unconscious knowledge while measuring linguistic behavior (White, 2018). However, online measures capturing automatic processes are not affected by having time to ponder metalinguistic knowledge. Automatic reactions measured with high temporal resolution can be taken to indicate underlying knowledge more reliably. In doing so, online methods provide a path to test whether or not HSs process their HL qualitatively differently from other sets of speakers of the same language. If they perform like dominant-native speakers, for example, this could indicate that HL grammars are more like native-dominant ones than differences in production, judgments and/or comprehension offline methods have suggested (Villegas, 2014). Alternatively, even if HSs process some domains of grammar qualitatively distinctly, online measures can help us to better understand and describe the coherent nature of their underlying grammars in their own right.

3.2 Online methods in HL studies

To date, the most widely used online methods have been self-paced reading, eye-tracking and masked priming tasks. In a *self-paced reading task*, participants are asked to read sentences on the screen presented one word (or phrase) at a time, pressing a button to move onto the next. The main assumption behind self-paced reading is that the amount of time taken to read a word reflects the amount of time needed to process that word. Thus, longer reading times mean processing difficulty, while faster reading times could be interpreted as a sign that facilitation occurred (Jegerski, 2014). Self-paced reading could be seen as a more implicit measure of grammatical competence, compared to offline judgments, because its time constraints prevent from relying on explicit grammar rules. At first glance, the use of self-paced reading could seem problematic in and of itself, at least for certain groups of HSs, given the above discussed concerns related to literacy effects. In studies using self-paced reading, however, it should be said that the focus is not (or should not be) on comparing overall reading times to dominant-native speakers. Rather, the goal is to understand whether HSs have qualitatively similar reactions to ungrammaticality, irrespective of overall speed. In other words, do HSs' reading times slow down after ungrammaticalities, relative to sentences with no violations, independent of how long they take to read overall? The differences between scripts across the languages can have obvious effects as well. And so, an alternative way to effectively accomplish the same goals would be to use self-paced listening.

Eye tracking measures where one focuses visual attention and eye movements. It is widely used in language processing, monolingual and bilingual alike, as it is argued to offer a window into the mind and, as such, an automatic measure into how language comprehension unfolds in real time (uses of cues for parsing, prediction/facilitation, etc., Demberg & Keller, 2008; Dussias, 2010; Holmqvist et al., [2011](#); Traxler & Pickering, 1996, Rayner, [1998](#)).

Although it is typically done with a task from which an accuracy measure can be derived, it does not require nor is it dependent on a secondary task, thus providing rich temporal data in and of itself. The eye-tracking methodology uses mainly two approaches: (i) recording the eyes' fixation patterns as a sentence is read, analyzing the time spent on each word/phrase; and (ii) the visual world paradigm in which participants' patterns of eye movements are tracked while they listen to phrases/sentences that correspond to one (or more) of the pictures they see on the screen. Both approaches have proven to be very informative tools for investigating sentence comprehension processes.

The *masked priming paradigm* (Foster and Davis, 1984; Kinoshita and Lupker, 2003) has been extensively used to study the online processing of a variety of lexical and morphosyntactic phenomena in different languages, in order to tap into the earliest stages of visual-word recognition. In the experiment, the prime (stimulus) is typically presented for a very short time ($\sim 50\text{ms}$) between a mask ($\lesssim 500\text{ms}$) and a target ($\lesssim 500\text{ms}$), making it virtually invisible and consciously unnoticeable. This presentation allows for investigating the effect of prime–target relationship at an unconscious level. For example, participants can be presented with a morphologically complex prime word like *walk* quickly enough that it is typically not noticed at the conscious level. They are then asked to perform a speeded lexical decision for a morphologically related target word (e.g., *walk-er*). Identification times to a target word are consistently faster when it has been preceded by a related word than an unrelated one such as *key* (within the same language and even across languages).

By comparison to other online methods, there have been fewer studies applying *electroencephalography (EEG) methods* to HL bilingualism (Martohardjono, Phillips, Madsen & Schwartz, 2017; van Rijswijk, 2016), despite the fact that they have been used increasingly in other bilingualism scenarios (see for review Roberts et al., 2018). EEG is a non-invasive electrophysiological method that is particularly well-suited for examining

online language processing. EEG records electrical activity at the scalp level. When time-locked to a stimulus of interest and averaged over numerous similar trials, this is referred to as an event related potential (ERP). ERP brain signals and their characteristic negative and positive deflections produced, known as components (see Luck, 2014 for an overview of the ERP technique), have been found to be modulated by different linguistic processes, making this technique suitable to examine the qualitative nature of language processing. Because there is a relatively well-established literature on dominant-native language processing using EEG/ERP, we can predict the brain signatures of how various types of grammatical violations are processed (e.g., early negativity for lexical semantic violations (N400), late positivities for syntactic violations (P600)) in what has been the typical baseline comparison for HSs. In the case one is more interested in revealing the underlying nature of HS individual differences, with large enough samples one could examine how individual HS brains react in terms of ERP components (e.g., Tanner, 2019) to the same phenomena or how amplitudinal differences within the same component might be differentially modulated by a set of linguistic factors (e.g., relative markedness: Alemán Bañón & Rothman, 2016, 2019) and/or experiential variables that distinguish HSs from one another. Like other online methods, EEG/ERP provides a real time measure of automatic language processing that is not subject to introspection like offline measures can be. What is gained in temporal resolution and measuring of automatic responses comes with some trade-offs. There are limitations to what can be done with ERPs related to how stimuli sentences need to be constructed and counterbalanced (ERP components themselves are the differences between a grammatical baseline and an ungrammatical counterpart) as well as the number of exemplars required (at least 30 per condition if not more, because the data are collapsed into grand averages needed to capture the subtle effects). As a result, not all linguistic properties are (as) easily tested with ERPs.

To date, of the relatively few studies using online methods some, which we detail below, have found differences between online and offline data, suggesting that online research methods, requiring less explicit knowledge, are more successful in revealing the underlying nature of HS grammars. Given that such methods are less subject to undesirable mitigation of various external factors, they might be most appropriate for studying HS knowledge. Minimally, the combination of online methods in complement to offline ones offers a very promising and powerful battery to test HL competence. In an effort to understand how and why it is important to combine online data with offline data, we briefly review the main findings of exemplar studies in relation to various online methodologies used. We also describe some in-progress studies building on the very limited work adopting an EEG/ERP approach, suggesting that this method is ripe for expansion in HL studies.

3.2.1 Self-paced reading studies

Jegerski (2018a) investigated the real time processing of Differential Object Marking (DOM) in Spanish HSs compared to late Spanish-English bilinguals using an offline acceptability judgment task and an online self-paced reading task. Previous offline studies showed a consistent variability with DOM in Spanish HSs (Montrul, 2014; Montrul & Bowles, 2009; Montrul & Sánchez-Walker, 2013). Jegerski (2018a) is the first study investigating the processing of sentences with DOM in Spanish HSs using an online measure. Results showed that both groups were sensitive to DOM marking of indirect object with inanimate direct object, but not to DOM marking with animate direct objects. Moreover, although there were no significant differences between the HSs and the late bilinguals for the online experiment, the HSs gave fewer determinate judgements during the offline task. The online results are important because they show that variability with DOM is not only limited to HSs, but it is also present in native-dominant speakers of Spanish who are late bilinguals

of English, where the construct of incomplete acquisition does not apply. The qualitative similarity in the two groups' online performances, in combination with indeterminacy in offline judgments for the HSs, seems to indicate that online measures can capture key information that is not reliably documented in offline performance.

In another example study, Keating, Jegerski, and VanPatten (2016) used a phrase-by-phrase self-paced reading task to investigate anaphora resolution in Spanish HSs of Mexican descent compared to monolingual Mexican Spanish speakers. The online data results showed that HSs responded in a different way to null vs. overt pronouns, following a similar pattern to monolingual controls. These findings run in contrast to a prior investigation (Keating, VanPatten, & Jegerski, 2011), where the same authors used an offline interpretation method, that showed that HSs processed null and overt pronouns in the same way. Keating, Jegerski, and VanPatten (2016) highlight the importance of using online methods, such as self-paced reading, to get a more informative picture of linguistic phenomena investigated so far only with offline methods.

3.2.2 Eye-tracking studies

Sekerina and Trueswell (2011) investigated the processing of contrastive constituents in Russian HSs compared to monolinguals in two eye-tracking experiments using a visual world paradigm. The authors used color adjective–noun phrases embedded into the split-constituent construction. Contrastiveness results from integration of multiple sources of information, e.g., word order, prosody and visual context. Their results showed that while monolingual controls used rapidly word order and visual context (but not prosody) to compute the contrast, Russian HSs of low proficiency were very slow, both in performing the task and in eye-movements. Moreover, to compute the contrast, HSs made use of multiple sources of information. Possible explanations for this slowdown might be that bilinguals in

general are slower in verbal tasks (Bialystok, 2009). Another could be that bilinguals have slower reading times because of their tendency to re-read, to re-analyze what they just read (Frenck-Mestre, 2002). The authors suggested instead that the slowdown in Russian HSs might reflect covert competition between their two languages starting at the level of spoken word recognition.

Jegerski and Sekerina (2019), following a prior investigation (Jegerski, 2018a), investigated auditory comprehension of DOM in Spanish HSs compared to adult immigrant bilinguals. In this study, the authors used a visual world eye-tracking paradigm, where participants were listening to *wh*-questions with the DOM particle *a* (*quién/a quién* ‘who/whom’) while their eye movements were recorded across four referent pictures. Results for verbal responses to the questions (offline method) showed that the HSs were less accurate but the online eye-tracking data revealed that both groups, HSs and native Spanish late English bilinguals, started to look at the correct picture at the same point in the question, suggesting that the two were similar in real-time processing for comprehension. Once again, results from the offline data differ from the online data in the same experiment. The difference is also in the direction that suggests online methods can capture a distinct level of granularity and showcase more convergent HL competence.

Van Rijswijk, Muntendam and Dijkstra (2017) used an eye-tracking reading experiment to explore whether the Dutch prosody of Turkish HSs living in the Netherlands differs from that of Dutch native-speakers who do not speak Turkish, and whether observed differences could be attributed to an effect of Turkish. Focus marking is different in Dutch and Turkish: Dutch mainly uses prosody to indicate focus, while Turkish uses both prosody and word order. In written sentences, no explicit prosody is available, which likely enhances the role of syntactic cues in interpreting focus. The authors found a difference in the total fixation durations between the HSs and controls. This result is in contrast with a previous

study (van Rijswijk, Muntendam & Dijkstra, 2017) that investigated focus marking in Dutch involving the same type of Turkish-Dutch HSs using an offline production task that revealed no difficulties in the HSs using prosody to mark focus. The differences in interpretations between HSs and controls in the eye-tracking experiment suggest that HSs relied on word order cues from their L1 (Turkish) to determine focus structure. This indeed showed an effect of Turkish L1 on Dutch L2, even though as HSs of Turkish they are overall more dominant in Dutch. These findings indicate that difficulties at the syntax-discourse interface are not necessarily visible in all modalities (i.e., speaking vs reading) and that some linguistic phenomena should be investigated using both offline and online methods in an effort to better explain variance in HSs' knowledge and performance.

In a final example study, Villegas (2014) investigated possible effects of immersion on comprehension and production in the linguistic representations of the Spanish subjunctive using online and offline methods. In the online comprehension experiment, the author used eye-tracking methodology to investigate whether native speakers of Spanish with different immersion experiences in the L2 (non-immersion, L1 native-late bilingual immersion, heritage speakers) differ in their ability to predict upcoming information while they read sentences in their L1. Overall, the results showed no significant differences between groups, suggesting that immersion did not affect speakers' predictive strategies during comprehension. The second experiment focused on the production of the subjunctive mood using an offline sentence completion task. The author wanted to determine whether there was a difference in the production of the subjunctive mood compared to comprehension. Interestingly, in this study HSs revealed significantly higher error rates in the production of the subjunctive mood compared to the non-immersed and the immersed L2 learner groups. These results suggest that HSs had difficulties in the production of the subjunctive mood but not during comprehension, pointing to complete grammatical representation. Villegas (2014)

reports another case where HSs performed differently in the online task compared to the offline one, raising awareness for future research to address *what* underlies the differences between production versus comprehension in online versus offline tasks in HSs.

The question of what would explain the distinct behaviors with different methodologies, and which result should be taken to best index knowledge comes to the fore. The answer is not straightforward and any attempt at an answer is likely to meet with some reasonable counter argumentation. However, the relevant point in a chapter like this one is to highlight that some linguistic phenomena should be investigated using both offline and online methods in an effort to better explain variance in HSs' knowledge and performance.

3.2.3 Masked priming studies

Jacob and Kırkıcı (2016) investigates the processing of morphological decomposition of complex words in Turkish HSs raised and living in Germany. The authors used materials and experimental design of a previous study (Kırkıcı & Clahsen, 2013) on morphological processing in Turkish native speakers and L2 learners, allowing for a comparison across the three groups. The study used two masked-priming experiments. The first experiment investigated priming effects for morphologically related prime-target pairs. HSs showed significant priming effects for prime-target pairs with inflected and derived primes, a pattern of results similar to the native-speaker comparison group. In the second experiment, the authors wanted to check whether the priming effects from the first experiment could be explained on the basis of orthographic overlap or not. HSs showed significant priming effects also in this experiment, unlike both L1 speakers raised in Turkey and highly proficient L2 learners. In sum, Turkish HSs were found to rely less on morpho-orthographic decomposition, while focusing mainly on the orthographic surface form. Their results stress how the HSs are a highly unique population, different from both native speakers and L2

learners, that could give us insights into how some linguistic phenomena undergo universal processing mechanisms, or whether they are shaped by the way the language has been acquired.

Jacob, Şafak, Demir and Kırkıcı (2019) compared the processing of derived and inflected morphologically complex Turkish words in Turkish HSs compared to Turkish native speakers, using a masked morphological priming experiment. Their results showed similar effects in the two groups, suggesting that morphological processing in HSs is based on the same processing mechanisms as in dominant-native Turkish speakers. Previous offline studies on morphology in HSs (e.g., Montrul et al., 2008; Polinsky, 2008) have reported differences between HSs and native-dominant speakers, claiming signs of attrition or incomplete acquisition in the HSs output. Jacob and colleagues' (2019) results show instead that HSs can develop monolingual-like processing mechanisms for complex words, even though they were exposed to a limited amount of input. Again, another exemplar study stressing the importance of using online research methods in the field of HLs, in order to shed some light on what might cause variance within the HS population.

3.2.4 EEG/ERP

Van Rijswijk (2016) compared the Dutch of Turkish HSs to the Dutch of L1 speakers in the Netherlands, covering language production (speaking) and comprehension (both listening and reading). Combining different research methods, both offline and online, the author investigates the use of prosody, and the encoding and decoding of information structure. The main aim of the thesis is to shed some light on the processing mechanisms that underlie the specific interactions between the HL and the dominant L2. The author used a production task to investigate prosody in the speaking modality, an eye-tracking experiment focused on prosody at the sentence level monitoring reading behavior (see above van

Rijswijk, Muntendam & Dijkstra, 2017), and finally an auditory lexical decision task with reaction times (RTs) and EEG to measure prosody at the word level studying the process of listening. In the auditory lexical decision experiments with RTs and EEG, van Rijswijk investigated various factors that might play a role in auditory cognate processing and the role of stress position in Turkish-Dutch cognates in Turkish HSs. Findings showed a cognate effect in both languages, Turkish and Dutch, but the direction of the effect (facilitation or inhibition) was different. For Dutch, the RTs revealed cognate facilitation that was supported by the EEG data, with a larger N400 for control words than for cognates, thus smaller lexical-semantic integration difficulties for cognates than for control words. By contrast, for Turkish, the RTs indicated cognate inhibition in all conditions. The non-significant difference between the N400 for cognates and control words pointed to a lack of cognate effect. In sum, van Rijswijk's (2016) study showed that language dominance, the status of the L1, and stress position all have an impact on auditory word processing in the HSs, providing evidence that linguistic transfer can also occur in the other direction (i.e., from the weaker L1 Turkish to the dominant L2 Dutch).

Martohardjono, Phillips, Madsen and Schwartz (2017) used a comprehensive methodological approach combining different experimental approaches, both online (ERP) and offline (acceptability judgments), with a sociolinguistic questionnaire probing proficiency, literacy, use, and exposure to both the HL and the dominant L2. The authors compared Spanish HSs and late bilinguals in an ERP experiment with auditorily presented stimuli seeking to show whether the two groups process in a similar or distinct way syntactically anomalous sentences in Spanish. To investigate the processing of Spanish sentences with grammatical structures that are anomalous in both Spanish and English, the participants listened to *wh*-questions containing a complex noun-phrase violation like (1a), and their grammatically correct counterparts like (1b). In both Spanish and English, sentences

like (1a) are not grammatically correct due to the presence of the head noun in the complex noun phrase.

- 1a. *Qué vecino contó Juan ||**el chisme** que robó el carro anoche?
What neighbor told Juan the rumor that robbed the car last night
'What neighbor did Juan say the rumor that robbed the car last night?'
- 1b. Qué vecino contó Juan Ø ||que robó el carro anoche?
What neighbor told Juan that robbed the car last night
'What neighbor did Juan say robbed the car last night?'

To investigate the processing of Spanish sentences with grammatical structures that are anomalous in Spanish but not in English, the participants listened to *wh*-questions with a missing complementizer *que* like (2a), and their grammatically correct counterparts like (2b). In Spanish, the absence of the complementizer *que* introducing the subordinate clause is not grammatically correct. This is in contrast to English, where the sentences with the presence of the complementizer *that* are instead ungrammatical.

- 2a. *Qué hermana confesó Inés Ø ||había comido la tarta?
What sister confessed Inés had eaten the cake
'What sister did Inés confess had eaten the cake?'
- 2b. Qué hermana confesó Inés ||**que** había comido la tarta?
What sister confessed Inés that had eaten the cake
'What sister did Inés confess had eaten the cake?'

In the EEG experiment, half of the trials contained ungrammatical *wh*-questions, like (1a) and (2a); and half contained grammatical *wh*-questions, like (1b) and (2b), that were used as controls and provided a baseline for EEG processing purposes.

The ERP data were then analyzed with linear mixed-effects models using responses collected in the linguistic background questionnaire as individual-level predictor variables in the model. Results showed that the two groups reacted the same, in terms of implicit responses. The authors found an N400 and a P600 in both late bilinguals and HSs. In the acceptability judgment (AJ) task, participants were asked to judge a subset of the items presented in the ERP task, using a five-point Likert scale. While for late bilinguals, data from

online and offline tasks aligned well, the explicit results for the HSs are in contrast with the implicit ERP data. In the AJ task, HSs showed less accuracy compared to late bilinguals, pointing again in the direction of a clear discrepancy in HSs' performance using offline and online measures. This study confirms again that measures requiring reflection and conscious manipulation of the language can underestimate HS competencies and result in a skewed picture when such results are generalized.

Unlike the other online methods where we presented exemplar studies from a larger cohort of available ones, on a continuum depending on the method, the two EEG studies presented here are the only ones, to our knowledge, that have been completed to date. Van Rijswijk (2016) and Martohardjono et al. (2017) are a good starting point, nevertheless they present some limitations. Van Rijswijk's (2016) study is an interesting attempt to examine prosody in HSs, unfortunately in the EEG study there was no control group because the focus was on L1 (Turkish) influence in the L2 (Dutch) of Turkish HSs living in the Netherlands. Nevertheless, they did compare their results with previous studies done on L1 and L2 populations, the result of which tentatively suggests that HSs performance shows a similar pattern as late L2 speakers. Furthermore, the language history questionnaire data were not correlated with the EEG measures. In HL studies, the weight of extra-linguistic factors, such as age of L2 onset, quantity and quality of exposure, formal vs. non-formal education in the HL and more, might contribute to explaining differences in performance between HSs and native-dominant speakers, as well as individual differences among the HSs themselves.

Conversely, Martohardjono et al. (2017) is the first study attempting to employ EEG/ERP to investigating HL proper. Combining different research methodologies (offline and online) and administering a language and social background questionnaire to identify those extra-linguistic factors that are most predictive of variance within the HS population, the study is a huge step in the right direction. The main criticism with Martohardjono et al.

(2017) study is related to some methodological issues: the number of items per condition used in the EEG experiment (N=15 items in condition 1 and N=20 items in condition 2) and the number of participants (late bilinguals N=20 and heritage speakers N=18). In EEG/ERP studies, due to signal to noise ratios and the very nature of how ERP components are derived (via grand averaging), these technical details can have an influence on the reliability of the data. To ensure that enough data after artifact rejection survives into the grand averaging analysis, it is crucial to have at least 20–25 participants and around 30–40 items per condition (less than .5 SD from the mean) to have confidence in what the analysis shows (e.g., Molinaro, Barber & Carreiras, 2011). And so, while the Martohardjono *et al.* study is very promising, further work is needed to see if what they show can be replicated and expanded under better normative conditions for EEG/ERP research.

Our work in progress combines offline linguistic testing, EEG (time-frequency oscillation and resting state) and ERP with in-depth sociolinguistic background questionnaires and measures of cognitive functions such as working memory, inhibitory control and pattern detection capacity. In line with the general trends we have seen in studies that combine offline and online measures or compare online ones with previous offline measures, the emerging interest in EEG/ERP studies promises to help us better understand the dynamic nature of HL competence and processing via methods that can capture involuntary, automatic responses to stimuli and probe correlations of variation. Given the nature of EEG/ERP and the level of granularity it can potential access, it stands out as a good method to combine in a battery of HS experimentation that we hope will become more mainstream in the near future.

4. Variation, correlation and complex statistical modelling

While the previous two sections relate to empirical testing methods proper, this section highlights how and why more fine-grained language background/language experience data collection in combination with more appropriate statistical modeling techniques can and should be used as an additional methodological innovation. Doing so is critically relevant to HS studies in general, since the methods typically used to date are, with few exceptions, have not been ideal for understanding the dynamic relationship and directionality of influence that key variables have for explaining HS outcomes. We believe that the field will not only engage more and more with underused statistical methods in the immediate future, but that it is imperative that we do so.

Over the last 20 plus years, descriptive studies have revealed a lot about the nature of HL grammars, but as is to be expected in a relatively new field, they have also left us with more questions than answers. There is a dearth of studies, much less bespoke HL theories themselves, offering testable and generalizable predictions for HL grammars in their own right. Such theories need to provide ways of predicting and accounting for at least two continua of variation across HL grammars, *(i)* the domains of grammar that are more and less vulnerable (and why) and *(ii)* the variables and their weighting that conspire to explain individual difference outcomes among HSs themselves.

In recent years, preliminary attempts at theories addressing, at least partially, *(i)* and *(ii)* above are emerging, including work by Putnam and Sánchez (2013) and Polinsky and Scontras (2020). As part of this general trend, we wish to highlight work in this final section that has shifted away from HS-to-monolingual differences towards HS-to-other bilingual and/or HS-to-HS comparisons in recent years. For certain questions, the HS-to-monolingual comparison is valid. Our intention is not to suggest otherwise. That said, this comparison is not always the ideal one, hence the work we focus on herein is being understood as increasingly more needed and welcome in the field.

While there certainly is individual variation in paths and outcomes for child L1 acquisition scenarios (see, e.g., de Houwer, 1995, 2007; Grüter & Paradis, 2014; Guasti, 2017; Haznedar, 2013; Nicoladis & Montanari, 2016; Meisel, 2004, 2011; Serratrice, 2013; Snyder, 2007), the range of individual variation in HS grammar far exceeds the ranges of other native-language acquisition scenarios, be it monolingual or bilingual. Nevertheless, as pointed out by Flores and Rinke (2019) and Kupisch and Rothman (2018), general statements that characterize HL bilingualism as “differ[ing] from the baseline language that served as the input for acquisition (Polinsky & Scontras, 2020:2)” must be qualified and taken with caution. While we are all interested in unpacking what variables predict and explain deviations, it is not always the case that HSs differ (see work reviewed in Kupisch and Rothman, 2018) and even when they do, some cases seem to show HSs’ overextending (not reducing or simplifying) licit constructions (Rinke, Flores & Barbosa, 2018) or reflecting variation that, while lacking in the so-called standard, exists in colloquial monolingual varieties (Rinke & Flores, 2014). And so, the range of HS outcomes (property-by-property in grammatical terms or overall fluency/proficiency in holistic terms) encompasses passive bilingualism with severely limited oracy ability to some individuals that are (nearly) indistinguishable from monolingual counterparts. It is not new to claim that the qualitative shape of input, from quantity reductions to the qualitative nature of it, should explain (some of) the differences between HSs and monolinguals, as well as capture some of the variance across the HS individual differences continuum (e.g., Montrul, 2004; Rothman, 2007, 2009; Sorace, 2004). However, very few attempts to actually model this have been undertaken.

Who would deny the veracity of the general statement claiming the input of HSs has consequences for their path and outcome? After all, no theory or hypothesis across paradigms denies that input is deterministic for all acquisition and, therefore, what is reasonable to expect as grammatical representational outcomes. Such statements made over the years by

many, ourselves included, are too simplistic. As always, the devil is in the details. What do we mean by reduction in input and how can we proxy this in measurement (as direct measurement is typically impossible) for means of modeling it meaningfully? What do we mean by quality of the input, beyond the obvious, which of course relates to honing in increasingly on appropriate baselines for HSs? What do we mean when we speak of opportunities for specific types of exposure, such as schooling or otherwise engagement with literacy in the HL? Until recently, and for very good reasons in the proper context, investigations of HL development and its outcomes had deemphasized the role of individual language experiences, or, better said, not considered them in the dynamic ways we are starting to do now. There is a general ethos in the field; HL studies have reached a level of maturity and critical mass of empirical work where transitional, predictive theories proper are ripe for creation. We have already discussed recent advances in this regard (e.g., Polinsky & Scontras, 2020). Now we turn our focus to work and specifically methods that can afford predictions for individual differences among HSs to understand how experiential factors relate to outcomes and what the directionality of influence as variables interact.

To date, most of the HL literature has traditionally used *means-based* statistical techniques such as ANOVAs and *t*-tests. This is partially because early studies started with investigations into HS-to-L2 speaker comparisons (Montrul, 2012). Doing so has effectively reduced the range of variability in the HL performance data (e.g., accuracy) into factorial categories juxtaposed against proficiency measured by self-evaluation or some type of standardized language tests. Information regarding individual experiences with one's languages, if collected at all, was used for achieving homogenous participant groups and/or accounting for potential outliers and variance of error in statistical (descriptive) analyses. Under this scenario, *reduced input conditions* often served as *catchall* explanations for HS-to-monolingual difference outcomes when on average HS performance was lower than that of

monolinguals, rather than unpacking these *conditions* to account for the gamut of individual variation existing within HS group. In a way, this is similar to stating that more than 20% of the Polar Ice Cap has melted since 1979 as a result of warmer air and ocean temperatures (aka, global warming) (NRCD, 2005) without explaining what has actually caused (and is causing) this change in the air and ocean temperatures. The observation alone is true and potentially enough for general consumption, but of course scientists and their vested stakeholders need to know why the general observation obtains. Today, thanks to advanced data collection and statistical modelling techniques not only do we know the key factors that have contributed to increase in the air and ocean temperatures and thus global warming in general, but also how these individual factors interact with each other and the environment in different parts of the world, we can also predict the current path and future outcome of this process (Parmesan & Yohe, 2003; Mora et al. 2017). Complex data-driven approaches are also becoming more and more widespread in linguistics applying more advanced modelling techniques, such as fixed- and mixed-effects regression modeling as well as other predictive modeling techniques such as discriminant function analysis (structural equation modeling) moderation modeling, classification/conditional inference trees and (random) forests (e.g., Gries, 2013, 2018; Baayen, Davidson, & Bates, 2008; Baayen, van Rij, de Cat, & Wood, 2018; Cunnings, 2012; Coupé, 2018; Pouplier, Cederbaum, Hoole, Marin, & Greven, 2017; Quené & van den Bergh, 2008).

Within the HS research context, however, such progress has been slow. Although it is only logical to assume that *reduced input conditions* lead to the observed divergence of HS grammatical competence from monolingual baselines, implementing advanced regression models and more rigorous data collection techniques (to get the data necessary for such analyses) is the next logical step. Below we review some recent studies that have made

preliminary steps forward at trying to unpack experience-based variables that potentially correlate to individual differences in HS performances.

Bayram et al. (2017), for instance, looked at the production of passives in the Turkish and German of young Turkish heritage speakers (age 9–15) in Germany, comparing them with age-matched monolingual speakers of Turkish and German. Differently from previous studies though, they focused on understanding the relative weight of key language experience factors (age at time of testing, immigration status of the Turkish parents (first or second generation), and literacy engagement with the HL) that might predict individual variation in HS performance. Data for factors such as degree of exposure to and engagement with the standard variety, parental immigration status, age of testing, etc. were collected and used as regressors in the analysis. The data were analyzed using a logistic mixed model, a type of Generalized Linear Mixed Model (Breslow & Clayton, 1993) that incorporates both fixed and random effects of factors (see Jaeger, 2008; Cunnings, 2012; and Coupé, 2018 for a discussion). The descriptive results show that all HSs used passives in both German and Turkish without being exposed to the structure/morphology in the experiment (this means producing unique morphology for passives in Turkish and changing case morphology) indicating that they have the underlying representation for passives in both Turkish and German. However, the aggregate results showed highly significant differences between the HS and the native Turkish controls in terms of proportional use, but not from the German controls. In other words, HSs use passives in German like German monolinguals but do not use passives in Turkish like monolinguals in Turkish. So far, the story aligns nicely with the previously documented HS-to-monolingual differences. That is, on average, HS performance was distinct from that of monolinguals. Was this, however, true of all individuals? Did any fall within the range of Turkish monolinguals? If so, what might predict which HSs did and did not? The logistic mixed model showed a significant effect of *literacy level* (see Bayram et

al., 2017 for how this was quantified) with no other significant main effects or interactions. Whether or not and for how long HSs had been in Sunday school classes provided by the Turkish government in its diaspora correlated nicely with individual HS performances; the more they had, the more likely they were to fall in the monolingual range.

In a similar vein, Gharibi and Boers (2017) used two vocabulary tests (verbal fluency test and auditory picture-word matching test) to investigate the vocabulary knowledge of simultaneous and sequential Persian-Iranian heritage speakers (age 6–18) in New Zealand, compared to their matched monolingual peers. They also utilized a detailed language background questionnaire to collect information about factors (age, age at emigration, length of emigration, frequency of heritage language use, and parents' attitude toward heritage language acquisition and maintenance) that were used in linear regression models to predict variation within the HS group. While the between-group comparisons were in line with previous research—that monolinguals outperformed the HS group—different demographic and sociolinguistic factors predicted different outcomes for each group. For instance, while the frequency of use of the HL was the second strongest predictor for both groups, age of arrival was the strongest predictor for the sequential HSs' performance and parental attitude toward the HL was the strongest predictor for the simultaneous HS group.

Most recently, Schmid and Karayayla (2019) looked at the productive use of various lexical and morphosyntactic structures (e.g., embedded clauses, evidentiality) by 92 Turkish-English adult bilinguals living in the UK with age of onset (AoO) varying from birth to adulthood (age 0 to 42), as well as a control group of 44 Turkish monolinguals. Importantly, they investigated the extent to which external language background factors (e.g., AoO, experience, exposure, attitudes toward the HL) predicted bilingual participants' proficiency in Turkish. They adapted Yilmaz's (2013) Personal Background Questionnaire for external language data and employed a number of tasks (e.g., semi-structured interview, picture

description task, verbal fluency task, C-Test, evidentiality experiment) to test participants' proficiency in Turkish. Their group comparison results are in line with previous research in that Turkish-English bilinguals' overall performance was degraded in comparison to their monolingual peers in all proficiency measures (lexical access, morphosyntactic complexity, and formal accuracy). In an attempt to account for the variation within the bilingual group, Schmid and Karayayla (2019) looked at the interaction between the proficiency measures and language background data. Moving away from the traditional regression models which were not able to capture the effect of these fine-grained and complex interactions, Schmid and Karayayla (2019) used Structural Equation Modelling (SEM) that, in a nutshell, is a flexible multivariate statistical approach that can assess unobservable latent constructs using one or more observed and measured variables. Their model measured the extent to which the outcome components (lexical access, morphosyntactic complexity, formal accuracy) weigh into *proficiency* (a latent construct), and finally tested the predictive relationship between the *background* construct and the *proficiency* construct. The results from the SEM analyses showed that exposure related factors (e.g., use, exposure, AoO) played a significant role in determining L1 (Turkish) proficiency in speakers who were exposed to English before age 10 (clear cases of HSs) while this effect disappeared with speakers who started learning English after age 10. We concur with Schmid and Karayayla's (2019) call for using more advanced statistical models that are capable of identifying the complex relationships between multiple variables and providing comprehensive explanations for the ways in which these (cause and effect) relationships obtain.

A crucial part of the HL bilingualism methodology equation that remains largely underdeveloped is the charting of input quantities and qualities as well as the usage patterns and domain distributions of the heritage and majority language. The idea is that, as is the case for other populations of bilinguals, understanding the linguistic experiences of HSs would, at

least in part, serve to explain some of the characterizing outcome variation. No one denies, nor should anyone be surprised, that HSs almost always deviate at the group level from L1-dominant natives. We, however, still know far too little about how much and, crucially, why HSs (can) differ from one another so much. In an ideal world, one would observe, record, and analyze all (or most) of the interactions of HSs within their environment from birth up to young adulthood to shed light on answers to these questions. One potential and promising way to circumvent the impracticality of doing so is increasing our use of standardized questionnaires widely used with other populations of bilinguals and able to measure in detail one's social experiences with their languages (e.g. LEAP-Q: Marian, Blumenfeld & Kaushanskaya, 2007; BILEC: Unsworth, 2013; LSBQ: Anderson et al., 2018).

These questionnaires offer composite scores that can be used as proxies for quantifying and qualifying input HSs receive, how they engage with and distribute use and function of the HL, relative dominance in one or the other language and more. Ideally, composite scores are backed up by significant norming and principled factor analyses that render the question sets used to derive relative scores more reliable than binary questions of self-reflection (e.g. relative self-assessment for proficiency). These scores can be used as regressors, much like common variables such as Age-of-Acquisition is, in an effort to see how experiential factors explain variance at the individual level. Doing so entails a shift in focus towards treating bilingualism in general, but specifically HLB, as a continuous construct, unpacking the dynamic nature of bilingualism as a spectrum of experiences and their correlations to (linguistic) outcomes. This of course does not mean that experiential factors alone neatly explain linguistic outcomes. However, we believe that the observable facts of HL bilingualism themselves highlight the inseparability of the social milieu of language at multiple levels (society and individual) and the outcomes of its acquisition. Of course, to do this meaningfully we will need to develop new questionnaires or sub-versions

of existing ones that are tailored specifically for HSs and their spectrum of realities with bilingual experiences. The desire is an end result where we have instruments able to record relevant information that is meaningful enough to distinguish types of HL bilinguals and reliably predict outcomes *a priori*.

5. Conclusions

What the above discussions and studies have in common is that all are pieces of a complex puzzle that come together to offer deeper insights and answers to complex questions pertaining to HL bilingualism. They reveal that the competence/performance variation within HS populations is not random; certain modalities might be more useful in capturing what heritage speakers know; combining online and offline measures might provide a more complete picture; and variation in individual experiences with the HL plays specific deterministic roles that can be successfully modelled. We submit that HL bilingualism studies will benefit from more work with research designs that include inter and within group investigations: (i) across various age groups and linguistic domains, (ii) with increasingly larger numbers of participants for more reliable estimate effect sizes (Kidd, Donnelly, & Christiansen, 2018), (iii) using questionnaires that can capture experience factors (from issues pertaining to input to language use and attitudes) made specifically for HSs, (iv) use the information gathered in (iii) to probe what factors correlate to outcomes at the individual level and finally (v) combine methods of empirical testing to gauge competence and processing at the same time. Doing the above will help achieve a fuller picture of variation at all levels: internal to a single HS's grammar and comparatively between HSs and whatever other populations are appropriate for any specific comparisons.

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