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CHAPTER 1

Introduction to Syntactic priming in language acquisition:

Representations, mechanisms and applications.

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It has been 35 years since Kathryn Bock published the first experimental investigation of *syntactic priming*, which is the tendency for speakers to repeat syntactic structures across successive utterances (Bock, 1986). Bock's empirical work built on prior observations of structural repetition in recordings of natural speech (e.g., Schenkein, 1980; Weiner & Labov, 1983) and has inspired decades of subsequent research extending this phenomenon to different populations, languages, contexts and structures (see e.g., Dell & Ferreira, 2016). It is now approaching 20 years since the first developmental syntactic priming study (as so named), extending this methodology to child populations, was published (Savage, Lieven, Theakston, & Tomasello, 2003). Although, researchers in the field of child language acquisition had been investigating how modelling and imitation relate to language acquisition many years earlier. Termed '*selective imitation*' in this early work (Whitehurst & Novak, 1973), the phenomenon of eliciting children's repetition of sentence phrase structure but not lexical content was investigated by a number of researchers in the early seventies with a view to understanding whether children's imitation of adults' language models supported their production and acquisition of phrase structures. This early research revealed that children selectively imitate only the grammatical form of previously modelled sentences in their own productions, (Harris & Hassemer, 1972; Whitehurst, Ironsmith, & Goldfein, 1974; Whitehurst & Novak, 1973; Whitehurst & Vasta, 1975), inspiring questions about how this behaviour might relate to and explain the naturalistic interactions between children and adults that ultimately support language development. As such, though the terminology may have changed, the field of child language has a long history of exploring how adults' use of language models, specifically models of sentence phrases and structures, influences (*primes*) children's own language production and learning.

Over the last two decades, there has been a proliferation of research examining priming of different syntactic structures in monolingual and bilingual children of different

ages and language backgrounds, who are developing language typically or not. This developmental research has extended our understanding of the syntactic priming phenomenon but has also improved our understanding of syntactic development. It is thus timely to take stock of this work and examine how far it has gone and where it still needs to go. This collection compiles original articles providing reviews of the state of the art in the child syntactic priming literature. The chapters explore what we have learnt from this research regarding children's developing representations of syntax in different circumstances and discuss how future work can build on and apply these insights through methodological innovations and broadening the scope of populations and language structures tested. In so doing, the volume (i) considers what we have learnt from the existing syntactic priming literature, (ii) identifies the limitations of that research, and (iii) explores what directions future research can take and how this will enhance our understanding of child language.

What is syntactic priming and how does it relate to language acquisition research?

Syntactic priming is the unconscious repetition of grammatical constructions across utterances (and speakers). Like other forms of priming, it is assumed to reflect facilitation of a particular stimulus such that that stimulus is more likely to be retrieved in subsequent processing. Here, the stimulus is the grammatical form by which a sentence is constructed. For example, a speaker is more likely to produce or expect to hear a *passive* construction (such as, *the idea was provided by a colleague*) if they have recently experienced another passive construction in a previous utterance (such as, *the book was written by the lecturer*) than if they have recently experienced the *active* alternative (*the lecturer wrote the book*).

Within the priming literature, the phenomenon is frequently referred to as *structural* priming, but this term is often used interchangeably with *syntactic* priming, or syntactic/structural *persistence* (e.g. Mahowald, James, Futrell, & Gibson, 2016). There are, however, different meanings associated with the terms (Pickering & Ferreira, 2008): 'syntactic' priming technically describes a more narrow phenomenon, that of the repetition of syntactic (constituent) form. 'Structural' priming on the other hand encompasses a more broad phenomenon whereby repetition can be related to other aspects of structure, such as the order of thematic roles (Chang, Bock, & Goldberg, 2003), noun animacy (Bock, Loebell, & Morey, 1992), or verb bias (Bernolet & Hartsuiker, 2010). 'Persistence' refers specifically to lasting effects of priming whereas the term 'priming' encompasses both immediate and lasting effects.

For this volume, the term 'syntactic priming' was chosen because, in the editor's opinion, this is the term that most aptly describes the developmental work that has been done. The focus of much developmental syntactic/structural priming work has been on uncovering the presence or nature of specifically syntactic representations because of a general focus on understanding whether and when children acquire abstract syntactic representations (see below). Relatedly, developmental priming experiments have typically examined repetition of syntactic form (e.g. passive vs active) irrespective of broader structural details (though there are noteable exceptions; Buckle, Lieven, & Theakston, 2017; Gámez, Shimpi, Waterfall, & Huttenlocher, 2009; Peter, Chang, Pine, Blything, & Rowland, 2015; Vasilyeva & Waterfall, 2012). For this reason, this volume describes and explores the phenomenon of *syntactic* priming in children but, as noted by more than one author, there is ample scope for expanding this focus to broader issues of structure in future work.

Syntactic priming is a naturally-occurring psycholinguistic phenomenon (Schenkein, 1980). Early experimental work stemmed from corpus-based observations that revealed repetition of grammatical structure in natural dialogues; subsequent corpus analyses have confirmed that syntactic priming occurs in ecologically valid contexts (as in experimental contexts) and have been able to examine a wide variety of predictors of structural repetition (see Gries & Koostra, 2017 for a review). However, since Bock's (1986) seminal work, syntactic priming has largely been exploited as an experimental manipulation, with great effect: syntactic priming studies have provided key evidence supporting psycholinguistic models of language representation and processing in a variety of speaker populations (see Branigan & Pickering, 2017; Mahowald et al., 2016; Pickering & Ferreira, 2008; Tooley & Traxler, 2010 for overviews).

It is widely believed that such repetition of grammatical structure occurs because speakers store mental representations of abstract language structures which they access during language comprehension and production. Processing an utterance primes the representation to be reused in subsequent utterances, though accounts differ as to what the representations are, how and where they are stored, and by what process priming is instantiated (Branigan & McLean, 2016; Branigan & Pickering, 2017; Chang, Dell, & Bock, 2006; Jaeger & Snider, 2013; Malhotra, Pickering, Branigan, & Bednar, 2008; Reitter, Keller, & Moore, 2011; Tooley & Traxler, 2010).

Systematic research of priming effects has informed our understanding of the nature of those representations in adult speakers: by manipulating the features of syntactic primes and observing what is repeated, it can be inferred what kind of representations underlie

priming effects. For example, in a series of early studies, Bock demonstrated that priming of sentence structure is not dependent on repeated lexical content (ditransitive sentences with a '*for*' preposition (*A cheerleader saved a seat for her friend*) are as likely to prime a ditransitive with a '*to*' preposition as a prime with a '*to*' preposition itself (*A cheerleader offered a seat to her friend*; Bock, 1989). Nor is it due to superficial similarities between sentences – a phonologically similar but structurally-unrelated sentence (e.g. the *to*-infinitive: *Susan brought a book to study*) will not prime a prepositional ditransitive response (*The widow drove the Mercedes to church*) – rather priming effects are elicited when sentences share constituent structures (Bock & Loebell, 1990). Moreover, Pickering & Branigan (1998) showed that syntactic priming is not affected by features such as the number, tense or aspect marking on verb phrases (e.g., a prepositional ditransitive with a past imperfective verb '*was showing*' is as likely to prime a prepositional ditransitive with a past perfective verb '*showed*' as a prime that also has a past perfective verb), further illustrating that priming is not related to superficial similarities between utterances. They did, however, demonstrate that repeated *open class* content words (in contrast to the repeated *closed class* content words tested by Bock (1989) enhanced the magnitude of priming, an effect (the lexical boost) that has been widely replicated (see e.g. Mahowald et al., 2016). In addition, priming effects are not related to language modality (comprehension or production) and transfer between the two (Bock, Dell, Chang, & Onishi, 2007; Branigan, Pickering, Liversedge, Stewart, & Urbach, 1995). These findings provide evidence that syntactic priming draws on a representation of grammatical structures that is based on constituent structures (e.g. noun, verb or prepositional phrases) and abstracted away from closed class content and features, and from language modality.

Furthermore, it is now widely accepted that syntactic priming leads not just to immediate repetition effects but also to a lasting tendency to re-use recently experienced language structures. Studies with adults reveal that priming persists over several intervening utterances between prime and target trials. That is, a speaker who heard a passive sentence would be more likely to use the passive structure in their own utterance than if they had heard an active sentence, even if a number of other utterances occurred in between (Bock & Griffin, 2000). Further, processing a block of utterances of the same syntactic structure increases the likelihood of speakers re-using that structure in subsequent language production, both immediately (Kaschak, 2007) and over delays of up to a week (Kaschak, Kutta, & Schatschneider, 2011). This evidence supports 'learning' explanations of syntactic priming, whereby speakers' representations of structures are dynamic and susceptible to lasting change

to reflect recent experience with language. Learning in this case is an adaptation to the input such that a speaker's expectations about what structure might be experienced, and their own use of structures, more accurately reflects the distribution of structures in the current discourse. However, in at least one account of such learning effects, the mechanism of this adaptation is linked to language acquisition processes (Chang et al., 2006). That is, the mechanism that creates syntactic priming effects in adult speakers is argued to be a vestige of the mechanism by which children identify and develop syntactic representations. As such, syntactic priming effects are said to involve a form of learning about how to use language, related to the mechanisms by which children first discover their language (see also Dell & Chang, 2014).

Given its utility as a paradigm for investigating grammatical representation and learning, syntactic priming has rightly been applied to address such questions in child language acquisition. For example, what do children know about the syntax of their language at different stages of development and in what kind of representations (e.g. lexicalised or abstract) is this information stored? Do experiences of syntactic priming have lasting effects on children's language processing, indicating that such experiences involve mechanisms related to learning about how their language is structured? This volume provides a state-of-the-art review of such research. The chapters explain what syntactic priming can reveal about child language acquisition across different populations, what the findings to date have revealed, and what innovations future research can take to move this field forwards and develop the depth of our understanding of developmental syntactic priming. Each of the chapters in this volume explores such issues for a different element of the current literature within one of three broad themes: syntactic priming in typically-developing monolingual children; syntactic priming in multilingual populations; and syntactic priming in atypically-developing populations. The rest of this chapter will set out the context of the following chapters.

Syntactic priming in typically-developing monolingual children

Early work on syntactic priming in children focussed on questions of representation: firstly, when do (typically-developing, monolingual) children have suitably abstract representations of syntactic structures that support priming across lexically-unrelated sentences (e.g. Huttenlocher, Vasilyeva, & Shimpi, 2004; Savage et al., 2003)? Such questions were a natural extension to theoretical debates about the nature of children's early grammatical knowledge (e.g. Fisher, 2002; Tomasello, 2000). Given that syntactic priming

effects are purported to stem from activation of a speaker's representations of syntactic structures, evidence of syntactic priming in young children across utterances that do not share lexical content is considered evidence that these children must have acquired *abstract* representations of grammatical structures, that is, representations that are not lexically-specified but rather consist of abstract word categories, such as *noun* and *verb*. In general, early research supported the conclusion that by 3- to 4- years of age, children have acquired a suitably abstract representation of structures, such as the active and passive transitive, or prepositional- and double-object datives to support priming across lexically unrelated utterances (Bencini & Valian, 2008; Huttenlocher et al., 2004; Shimpi, Gámez, Huttenlocher, & Vasilyeva, 2007; Thothathiri & Snedeker, 2008, cf. Savage et al., 2003; though see Kidd (2012b) and Rowland, Chang, Ambridge, Pine, and Lieven (2012) for further discussion).

Whilst such findings provide evidence against earlier lexicalist theories of grammar development, which argued that abstract representations of grammar are not developed until much later in development (e.g. Tomasello, 1992), they do not resolve the debate about the nature of children's earliest representations of syntax. Being mostly based on children's *production* of target sentence structures (cf. Thothathiri & Snedeker, 2008), they are limited to a relatively late stage of grammatical development when children have acquired both the grammatical knowledge to support sentence processing but also the production skills required to demonstrate it. This leaves open the question of what children's grammatical knowledge is like at earlier stages of development, a point raised in Chapter 2 by Contemori. Amongst a broader review of the literature, Contemori considers the extent to which syntactic priming research has addressed the question of what syntactic priming can reveal about children's early grammatical knowledge. She proposes ways in which future research that extends priming work to new structures, languages and settings can improve our understanding of what syntactic priming effects reveal about children's syntactic competence.

Subsequent developmental priming work moved beyond this question of whether and when children acquire the syntactic representations needed to support productive language use. One line of research has been to delve further into the nature of the representations that young children acquire, based on the premise that the presence of a priming effect across utterances would indicate that the processing of those utterances was supported by a single representation. Research with children has shown that their early representations for passives do not discriminate between different classes of verb (Messenger, Branigan, McLean, & Sorace, 2012) and that a common representation underlies the processing of short (*the kings are being surprised*) and full (*the kings are being surprised by the clowns*) passive forms

(Messenger, Branigan, & McLean, 2011). Some research has looked beyond the repetition of syntactic forms to explore priming of other elements of structure, revealing that children can be primed to produce syntactic forms based on overlapping thematic structure (Gámez et al., 2009; Vasilyeva & Waterfall, 2012), verb biases for particular structures (Peter et al., 2015), or noun animacy arrangements (Buckle et al., 2017).

In Chapter 3, Foltz develops this topic by considering how syntactic priming can be used to test not just the existence of abstract representations but the nature of those representations. In particular, Foltz makes the appeal for future work to widen the testing base beyond the reliance on priming passives in English. She highlights a number of different aspects of grammar that future syntactic priming research could address to better our understanding of the nature of children's developing representations. Moreover, she considers how other linguistic features, such as the frequency and complexity of syntactic forms and the repetition of lexical content, modulate syntactic priming effects.

Another direction that developmental priming studies have taken, in line with directions in the adult priming literature, is to explore how behavioural evidence from children supports models of syntactic priming as learning, that is, examining whether there is evidence that priming experiences have a lasting effect on the language that children understand and produce. Since the evidence from adult speakers increasingly supports the idea that priming effects are related to a mechanism of dynamic and adaptive representations, and an influential model links this mechanism to language development processes, there is a particular need for the developmental literature to explore such effects. A number of studies have demonstrated that priming effects persist across target utterances within a single testing session (Branigan & McLean, 2016; Gámez & Shimpi, 2016; Huttenlocher et al., 2004; Kidd, 2012a, 2012b; Messenger, 2021), whilst others have shown that these effects persist over longer periods (Branigan & Messenger, 2016; Savage, Lieven, Theakston, & Tomasello, 2006; Vasilyeva, Huttenlocher, & Waterfall, 2006). Other research has investigated related aspects of implicit learning models of priming such as surprisal effects (Peter et al., 2015) and learning via prediction (Fazekas, Jessop, Pine, & Rowland, 2020). In Chapter 4, Messenger, Branigan, Buckle and Lindsay consider implicit learning models of syntactic priming and review how well the existing evidence supports such accounts, proposing ways in which future research can address particular predictions of these models.

Despite these varied approaches to syntactic priming in child language, the current findings remain limited in important ways. Chapters 2 to 4 all highlight that the field would benefit from research on different languages and syntactic structures. But a further limitation

to the current literature is that the vast majority of child priming studies have examined priming as measured by children's production of target structures. As noted above, this limits the ages at which priming can be observed and confounds our understanding of what priming effects reveal about children's syntactic knowledge with any limitations in their language production skills. It also leaves a major component of language processing, and learning (implicit learning accounts of priming site learning within comprehension processes), largely unexplored. In Chapter 5, Atkinson questions this limitation and the reasons behind it, and explores the methodological and theoretical benefits of studying priming of children's sentence comprehension. This chapter also presents a study that uses comprehension priming to test a structural alternation that has not been used in prior child syntactic priming research, ambiguous prepositional phrase attachment (e.g. Branigan, Pickering, & McLean, 2005), illustrating the benefits of extending child syntactic priming research to comprehension studies.

These first four chapters focus primarily on what syntactic priming can tell us about language acquisition in typically-developing, monolingual children. The following five chapters explore how syntactic priming can be used with different populations to further our understanding of multilingual language acquisition and language acquisition in atypically-developing populations.

Syntactic priming in multilingual populations

In parallel to research on monolingual children, other researchers have applied the syntactic priming methodology to explore priming in children acquiring more than one language, also following developments in the adult priming literature. Researchers investigating adult bilingual speakers have used syntactic priming studies to investigate the language representations of bi- or multi-lingual speakers, given the utility of syntactic priming as a tool for tapping into speakers' representations of language. This research has focussed specifically on the question of whether or not speakers of more than one language represent each language separately or have shared representations where commonalities between the two languages exist (see Van Gompel and Arai (2018) for a review). Research with adults support the idea that proficient adults speakers of two or more languages have 'shared syntax' (e.g. Hartsuiker, Pickering, & Veltkamp, 2004): *cross-linguistic* priming effects (syntactic priming of a syntactic form from one language to another) imply that bilingual speakers store a shared syntactic representation that they use when processing both languages, rather than separate representations for each language. In Chapter 6, Gámez,

Vasilyeva and Perry review this evidence and the (albeit limited) extent to which such findings have been replicated within developing bilinguals. They further consider how well the shared syntax account (Hartsuiker et al., 2004), which was developed to describe adult bilinguals' language knowledge, can describe the development of such knowledge in young, simultaneous bilinguals.

In Chapter 7, Serratrice addresses the same issue of what kind of representations bilingual children develop and how but approaches it from the perspective of cross-linguistic influence, the notion that language use in one of a bilingual's languages can be influenced by aspects of their other language. This idea has been prominent in theories of how speakers of more than one language represent linguistic structures, and in this chapter, Serratrice relates cross-linguistic influence to (cross-linguistic) syntactic priming. She highlights how syntactic priming may provide a framework for understanding cross-linguistic influence as well as a methodology for testing it. Both Chapters 6 and 7 acknowledge that this area of the child priming literature is very much in its infancy and both chapters make a number of suggestions for how future syntactic priming research can develop our understanding of how child speakers of more than one language acquire, represent and process their languages.

Syntactic priming in atypically-developing populations

In the last set of chapters, the role of syntactic priming in understanding child language acquisition in atypical circumstances is explored. Since syntactic priming effects are indicative of both the existence of syntactic representations and also the nature of those representations, this manipulation is a useful tool for examining what children acquiring language in different circumstances know and to what extent this differs to or is the same as typically-developing children. Moreover, priming studies provide a means to understanding how children respond to their linguistic environment, specifically the linguistic input they receive, which is particularly important when children's abilities to do so are in some way different or impaired. Correspondingly, research on developmental syntactic priming has been extended to children with autism (e.g. Allen, Haywood, Rajendran, & Branigan, 2011) and children with developmental language disorder (DLD; e.g. Garraffa, Coco, & Branigan, 2015) to explore where differences and impairments in syntactic development and processing may be evidenced by syntactic priming effects. In Chapter 8, Hopkins examines syntactic priming in children with autism, a population in which priming effects might be predicted to be reduced on account of grammatical and – or imitation impairments. As Hopkins sets out, the evidence points to the contrary, children with autism display typical syntactic priming

effects, if not over-alignment, demonstrating that syntactic priming studies provide a useful tool for understanding the locus of impairments in children with autism's language production. Hopkins considers possible explanations for these findings as well as ways in which future research can develop our understanding of the nature of language and communication impairments in this population. In Chapter 9, Garraffa and Smith focus on grammatical development in children with DLD: here, they review existing studies on children with DLD and consider whether syntactic priming is a useful paradigm for assessing impairment as it permits a test of whether representational deficits or processing and learning deficits are at the heart of DLD impairments. The authors contrast this developmental work with research on an acquired language disorder, aphasia, to further this discussion of the role of syntactic priming in identifying the locus of impairments.

In addition to measuring what children know and can do, the mechanistic nature of priming means that it has potential to be used as a tool for language intervention. Syntactic priming has been shown to be effective in supporting long-term changes in typically-developing children's language use (Hesketh, Serratrice, & Ashworth, 2016; Serratrice, Hesketh, & Ashworth, 2015; Vasilyeva et al., 2006), whilst others have noted its potential for use as a speech and language therapy device (Leonard, 2011). In Chapter 10, Leonard, Krok and Wisman Weil examine how syntactic priming methods can be translated into clinical practice to provide language intervention to children with grammatical deficits. They consider the ways in which syntactic priming is akin to language intervention and review how existing evidence from studies that have used a syntactic priming method with children with grammar impairments supports this idea. They provide practical suggestions for how syntactic priming may be implemented in clinical settings as well as suggestions for future research directions that would help to refine this methodology. In this chapter, as in the other chapters within this theme, they also highlight the 'virtuous circle' benefits of research with atypically-developing populations: such research has benefits for understanding of atypical development but it also improves our understanding of syntactic priming more generally. For example, by testing children from different backgrounds and testing priming in different contexts, we can test different theories about what is necessary for syntactic priming to occur and what makes syntactic priming more effective.

Conclusion

The aim of this collection is to provide a source that complements existing published research on syntactic priming in child populations by drawing out key themes and ideas from

the current literature, taking stock of what it has achieved, and identifying new directions that future research can take. Syntactic priming provides a means to testing what children know about the grammar of their language(s) and how they learn to use it; as such it also provides a means to explaining how children's grammatical knowledge is structured and launched during sentence processing and the mechanisms that generate this. The following chapters will hopefully convince the reader of the merits of syntactic priming as a methodology and as a model for understanding child language acquisition. As outlined above, all chapters provide a review of current evidence and accounts of syntactic priming in child language acquisition, and its application to different populations and understanding of language acquisition in varying circumstances. Additionally, all chapters provide a set of proposals for how future research can build on current methods and findings to address unanswered questions, posing relevant questions and providing insight on methodological improvements. The hope is that these suggestions will inspire future work that will help to develop more refined theories and models of language processing and acquisition, as evidenced by the phenomenon of syntactic priming.

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