Children's acquisition of verb inflection in Japanese: contrasting generativist and constructivist approaches

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Abstract

The present dissertation investigates the mechanisms by which children learn inflectional morphology, by studying children's acquisition of verb inflection in Japanese.

In the field of child language acquisition, children's acquisition of verb inflection has long been considered an important test case for theories of language acquisition. This is because systems of inflection, at least in the adult grammar, exhibit the properties of both abstractness and productivity that characterise linguistic knowledge. Thus children are assumed not only to learn the ready-inflected forms that they hear in the input language (e.g. *tabeta, neta, omotta* 'ate', 'slept', 'thought') but also to recognise and abstract patterns among these forms (e.g., *-ta* past marker) and to use these generalizations to apply inflection productively to new verbs.

Children's acquisition of inflectional morphology has been explained by two contrasting approaches: the generativist/nativist approach and the usage-based/constructivist approach. The generativist approach is exemplified by Chomsky's generative grammar (Chomsky, 1957; 1965) and related theories (e.g. Guasti, 2004, Hyams, 1986; Radford, 2004, Wexler, 1994; 1998), and characterised by the view that the grammar is a set of categorical rules and constraints that are either specified innately or acquired with a minimal amount of exposure to the input language (e.g. via parameter setting). The usage-based/constructivist view, on the other hand, emphasises the importance of the input language, and argues that children's early grammar develops out of specific instances in the input, and so reflects the probabilistic distributional pattern of the input language (e.g. Bybee, 1996; 2010; Ambridge & Lieven, 2011; Tomasello, 2000; 2003).

These two accounts make different predictions regarding children's acquisition of verb inflection. While the generativist account predicts early productivity and categorical patterns in young children's use of inflections, the constructivist account predicts a pattern of usage that reflects the frequency distribution of the input. However, contrasting these two views has not been straightforward, partly because of general methodological problems with previous studies (e.g. the failure to control for sampling effects and for other variables correlated with frequency), and partly because of certain structural and distributional characteristics of the languages that have been studied so far (e.g. a general preponderance of one particular type of inflectional morpheme – e.g. third person singular – that holds across all verbs).

The key contribution of this dissertation lie with its focus on Japanese verb inflection; a systems in which many inflectional categories are marked by means of agglutinative morphology, and in which the usage pattern of inflections exhibits considerable variation across verbs (e.g. past inflection is more frequent than nonpast inflection for some verbs, with the reverse true for others). These properties of Japanese prove to be extremely useful for investigating whether children's acquisition of inflection can best be accounted for in terms of grammatical categories or of the distributional patterns in the input, and thus for distinguishing the two theoretical views of language acquisition more generally.

The dissertation consists of four studies, each of which investigates Japanese-speaking children's use of inflection to answer a theoretically-motivated question. The first study (Chapter 4) is a corpus-based study that focuses on the age/order of acquisition of verb inflection. This study investigated whether there is a fixed common order in the acquisition of inflections, and explored what factors determine the age of acquisition of inflected forms, by analyzing the effects of input frequency and morphology. The important implications of this study are that the earliest verb forms show considerable variation across children that resists a categorical generalization, and that the learning of whole inflected forms is important. Chapter 5 reports another corpus-based study that contrasts the generativist and constructivist predictions by investigating the usage pattern of different inflections. Specifically, this study finds that children's earliest verb forms, errors, and usage patterns for past and other inflections do not support the generativist hypothesis that the past inflection has a default status in the early grammar. Instead, children's use of these inflections showed a high correlation with distribution in their caregivers' language. The study reported in Chapter 6 experimentally confirmed this support for the constructivist view. This study sampled children's errors with past and nonpast tense inflections using sentence-completion tasks, and revealed a bi-directional error pattern for these two inflections. That is, children were more likely to correctly use and over-use past forms for verbs whose past forms outnumber nonpast forms in the input, and vice versa for verbs whose nonpast forms outnumber past forms. The fact that the likelihood of these errors is explained by the relative frequency of these inflected forms in child-directed speech provides strong support for the constructivist account. The study reported in Chapter 7 replicated this by-verb effect of input frequency in children's production of morphologically simple and complex inflections in an elicitation experiment. After controlling for a confounded factor, namely morpho-phonological complexity, this study revealed an effect of input frequency over and above this factor and extended the input-based learning account to a wider range of linguistic forms (stative and completive).

These studies, which investigated different aspects of children's acquisition of Japanese verb inflection with carefully controlled methodology, have replicated and extended effects of input frequency observed in previous studies of inflectional morphology. Thus, despite some unexpected outcome that highlight factors to be explored in future research, the findings of these studies together constitute strong support for the input-based learning view that lies at the heart of usage-based/constructivist theories.

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This dissertation would not have been completed without a number of people who helped me on different phases of research. My supervisors, Prof. Julian M. Pine, Dr. Ben Ambridge and Dr. Franklin Chang, have always been supportive and given me so much inspiration and motivation for the linguistic research. Their professional instructions and advice have been essential not only for the current dissertation but also for the whole learning experience during the postgraduate course. I am grateful to my main supervisor Prof. Julian M. Pine in particular for having accepted me first as a visiting student, and then as a Ph.D. student, which has been a wonderful opportunity for me.

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I express my gratitude to all the people in nurseries and kindergartens who have accepted my projects and been very supportive in running the studies. I also thank all the children who participated in the experiments.

Rationale for submitting the thesis in an alternative format

This dissertation has been submitted in an alternative paper format, which consists of research chapters that are in a format suitable for submission for publication in a peer-reviewed scientific journal. However, the formatting of these papers has been matched to the overall formatting of the thesis for consistency. For instance, all the references and appendices are listed together at the end of the thesis. In all other respects the chapters have been formatted as if they had been published or submitted for publication. This alternative format does not differ from the standards that are expected for a traditional dissertation.

Since the research chapters are written as independent publishable papers, each chapter is preceded by a short section that contextualises each study within a wider theoretical and empirical context and debate in the literature, in order to maintain the coherence and the flow of the thesis as a whole.

The thesis begins with some general introductory chapters that review the background of the research (Chapters 1, 2, and 3) and concludes with a general discussion that summarises and discusses the overall outcomes of the research and how they fit into the wider context (Chapter 8). The main components of this dissertation are four research chapters that correspond to two corpus studies and two experimental studies, all of them in publishable or published paper format. The first study is a corpus study that has been submitted to *Language Learning* (Chapter 4). The second study is another corpus study that is published in the *Journal of Child Language* (Chapter 5). The third study is an experimental study submitted to *Journal of Child Language* (Chapter 6). The last study is an experimental study submitted to *Cognitive Science* (Chapter 7).

The supervisors for my Ph.D. program, Prof. Julian M. Pine, Dr. Ben Ambridge and Dr. Franklin Chang, have provided helpful advice and instruction on all phases of research as well as on the current dissertation. Because all the published papers are co-authored with them, it is worth specifying that my own contribution to the papers is as follows. In addition to researching the literature and the research questions for each experimental paper, I have been responsible for the design of the studies including procedure and materials (pictures, audios, etc.), recruiting, testing participants, coding and analysing the data, writing the papers, submitting them to the journals, and corresponding with the journals regarding revisions.

The reason for completing the doctoral dissertation in this format is my wish to quickly deliver the findings of this work to a wider community. Submitting and publishing studies in international peer-reviewed journals is essential for improving the quality of research output to meet the high standard of these journals through the peer review process.

At the same time, because the wide research community has access to the research, the findings are subject to criticism and evaluation, and incorporated in important arguments in the field, so becoming a part of the rich literature on how children acquire their first language.

Chapter 1: Introduction to child language acquisition

1. Thesis introduction

This doctoral dissertation presents psycholinguistic studies on language acquisition that test some of the theoretical assumptions about how young children acquire inflectional morphology by focusing on Japanese.

Language acquisition refers to the field of research on how children learn language. This topic is investigated in psycholinguistics as well as in other related scientific disciplines such as developmental psychology. Other names such as first language acquisition, language learning or child language can be used alternatively.

In this field, different learning accounts have been proposed for how children learn, represent and produce language. One of the most discussed topics is inflectional morphology, with which speakers can productively modify words. Explanations for how children learn different inflectional categories and individual inflected words differ substantially between nativist/generativist and usage-based/constructivist theories. The current work tests several predictions from these accounts by focusing on the grammatical features and probabilistic nature of Japanese verbs. The item-specific distribution of inflectional forms is the key to detecting the factors that underlie children's learning, to comparing different theoretical views, and consequently to better understanding the learning process. To this end, I have conducted four studies, each of which has its own research question and quantitative method. The structure of the dissertation is as follows.

Chapter 1 of this dissertation presents an introductory summary of two major theoretical approaches; nativist theories and usage-based/constructivist views. This chapter aims to present the general ideas behind these theories that have played a central role in the literature on language acquisition.

Chapter 2 presents an introduction to the acquisition of inflectional morphology. This chapter explains the basic assumptions about how children learn inflection under the two theoretical accounts.

Chapter 3 introduces inflectional morphology in Japanese as well as providing a general sketch of the grammar and morphology of the language. The review of relevant literature is followed by the research questions that are addressed in the dissertation.

Chapters 4 to Chapter 7 consist of four separate studies on the acquisition of Japanese verb inflection. Chapter 4 investigates the order and age of acquisition of verb inflections using naturalistic speech data. The first part of this study addresses the question of whether there is a fixed order in the acquisition of inflections, while the second and the third parts

explore the factors that explain age of acquisition focusing on input frequency and morphology.

Chapter 5 reports a second naturalistic study testing generativist and constructivist predictions regarding children's early verb use. Specifically, this study looks at children's earliest verb forms, errors and usage pattern in order to see whether the past inflection is used as a default across verbs or whether the distribution of inflections reflects the probabilistic pattern in the input.

Chapter 6 reports an experimental study that is designed to provide a stronger test of the same generativist and constructivist predictions. Children's production of past and nonpast inflections was investigated used an elicited production experiment, and the error patterns observed analysed in terms of the frequency distribution of these two forms in the input.

Chapter 7 uses a similar elicitation paradigm to test whether children's production of morphologically simple and complex forms is explained by input frequency over and above differences in morphological complexity. This study is thus intended to provide a particularly strong test of the often-confounded effect of morphological complexity.

Chapter 8 provides a general discussion of the findings. The findings from the individual studies are summarised and interpreted in the light of the literature from the two contrasting theoretical approaches. Conclusions are drawn by contrasting the two theoretical viewpoints, and recommendations made for future research.

2. Theories of child language acquisition

Human children learn to speak language during the earliest years of their life. How they learn language has been an important field of linguistic and psychological research because of language's complex symbolic nature, and its fundamental role in every aspect of our lives, including communicating, thinking and learning among others. Research on how children acquire language aims to reveal the nature of language as well as of the human mind (see Chomsky, 1965; Tomasello, 2003; Pinker, 1984). A number of researchers have observed children's language, described phenomena, and proposed different theories of acquisition. This section outlines some of the most important theoretical accounts in the field and contrasts them in order to contextualise the present dissertation.

2.1 Overview of child language theories and frameworks

When the modern study of language acquisition started around the late 19th century, research was mainly based on diary data that mothers kept for their children (see Ingram, 1989, for reviews). The diary data with close observation on children's vocalisations and language production was a rich source of data that allowed important descriptions of how child language develops. These early descriptive studies provided a foundation for later acquisition research that became more systematic and theory-building.

A key milestone in the literature on language acquisition was the publication in 1957 of Noam Chomsky's book: 'Syntactic Structures'. Before this point, the theoretical trend in the field was towards Behaviourism, with a strong influence from biological sciences. This trend culminated in Skinner's (1957) book: 'Verbal Behavior', in which he argued that language acquisition could be understood in terms of general principles of learning and reinforcement. Chomsky's criticism of this behaviourist view emphasised the hierarchical complexity and abstract nature of language, and argued for the domain-specific knowledge of language in the form of a generative grammar, built on the basis of innate grammatical knowledge. Early versions of generative grammar were replaced, in the 1980s, by the Principles and Parameters Framework (also known also as Government and Binding theory, Chomsky, 1982) and Lexical Functional Grammar (Bresnan and Kaplan, 1982; Pinker, 1984). A major focus of these approaches was the link between child and adult language. These approaches have been replaced more recently by the Minimalist Program (Chomsky, 1995), but nativist/generativist theories continue to be influential in the field.

Nativist theories can be contrasted with another major stream of acquisition research that originated in American functionalism around the 1960s, when linguists started to look at frequency effects in helping to explain cross-linguistic patterns across grammatical constructions (Greenberg, 1966). One of the most important works on language acquisition in this period was Braine's (1963) study in which he observed structures that consisted of fixed and variable parts and proposed the idea of 'pivot grammar'. Braine focused on children's language use in context, and looked for the psychologically real categories and rules used by young children. Braine and other researchers such as Brown (1973), Schlesinger (1971), Bloom (1973), and Slobin (1971) were pivotal in the rise of acquisition research that took cognitive development into account. This line of research has developed into usage-based/constructivist theories on language acquisition, and has become another major trend in the current field. The term 'usage-based' was originally coined by Langacker (1987, 1988) for his model in cognitive linguistics, and has been used for closely related approaches that

argue for the importance of language use, and attempt to use a variety of different domain-general learning mechanisms to explain the acquisition of language structure (e.g, Bybee, 1995; 2001; Tomasello, 1992; 2003). The terms 'usage-based' and 'constructivist' are used interchangeably in this thesis. The following sections give a general description of the nativist and usage-based/constructivist accounts that play central roles in present-day research on language acquisition.

2.2 Nativist theories

2.2.1 The history of linguistic nativism

Linguistic nativism emerged as a result of Chomsky's critique of behaviourist models of language acquisition. The behaviourist view of language learning is represented by Skinner's (1957) argument that children learn language through fine-grained selective reinforcement by parents or caregivers. That is, children learn the association between their language production and its consequences, which is the response or reaction of their interlocutor that follows their production. For example, if a child attempts to imitate an adult saying the word Mummy, the parent may 'reward' close attempts (e.g. with praise or smiles) but not clear errors (e.g. baba) (Ambridge & Lieven. 2011; 104). Skinner's ideas about reinforcement are based on his biological work related to the "law of conditioning" which states that if the occurrence of an operant is followed by the presence of a reinforcing stimulus, the strength of the operant is increased (Skinner, 1938). Language acquisition is explained in a similar way to non-linguistic learning processes such as rats learning on the basis of food reward. The behaviourist view assigns very little internal structure or knowledge about language to the child; it simply assumes general abilities such as the ability to form associations.

Chomsky (1959) criticised this idea on the basis of the complex and abstract nature of language, which is what makes human language unique among other human psychological phenomena or other animals'communication systems. Speakers know what is grammatically acceptable or not (knowledge of grammaticality) and they are also able to cope with the ambiguity of language (how to determine the correct meaning from many possible readings). In addition to these abstract features, Chomsky's criticism is also motivated by the fact that children quickly and effortlessly acquire language and that this acquisition process is universally observed across children and languages. He claimed that, given these characteristics language could not be learnt simply on the basis of selective reinforcement.

Instead, Chomsky posited that children had to achieve the fast universal acquisition of an abstract and complex system of language by a process of active hypothesis testing. He therefore proposed an innate theory of language in which the possible structures of human language are represented in the mind/brain and guide acquisition. This view has developed into an important framework in which researchers have proposed a variety of different theories, all of which have these fundamental nativist assumptions in common.

2.2.2 Grammar in nativist theories

In nativist accounts, to know a language means to possess a psychological system of knowledge called grammar. This system is characterised as a hierarchical mental generative procedure that uses finite means to generate an potentially infinite number of sentences (Chomsky, 1965; Guasti, 2004; Ingram, 1989). The finite means refer to the set of rules, constraints and categories that define grammatical structures. The generative nature of human language is considered its most essential feature, which is why this theoretical framework is often referred to as generative grammar. In this approach, the psychological system of knowledge, or competence (the speaker-hearer's knowledge of his language) is the only target of linguistic inquiry as opposed to language use or performance.

In particular, Universal Grammar (UG) represents the initial linguistic state of human beings, that is, the genetic equipment necessary for acquiring a language (Guasti, 2004). UG was originally proposed to solve the problem of the *poverty of the stimulus* (Chomsky, 1968), and has been described differently in later theories.

Chomsky's earliest theory was Transformational Grammar (also referred to as Phrase-structure grammar and Standard theory), which consists of a set of transformational rules that generate specific surface structures from underlying structures (Chomsky, 1957). Chomsky considered the underlying structure to be universal across languages. Since Chomsky (1981), Government and Binding theory, also known as Principles and Parameters theory, has become influential. According to this view, Universal Grammar (UG) is composed of universal principles and non-universal parameters that are set differently depending on the language. Instead of construction-specific transformational rules (e.g. the passive transformation), this theory assumes that specific structures are generated from the interaction of more general principles such as movement of argument (A-movement) and assignment of subject role (e.g. Ambridge & Lieven, 2011; Guasti, 2004). Principles and Parameters theory attempts to explain the ease with which children learn by reducing the child's task to the setting of parameters. More recently, the Minimalist program (Chomsky, 1993) has become

influential. This theory pursues the question of economy and learnability further, while taking into consideration the relationship with language and other cognitive systems (e.g. Radford, 2004).

2.2.3 Nativist views of language acquisition

2.2.3.1 Learnability issues in first language acquisition

Explaining certain aspects of language acquisition, such as the universally fast process of acquisition in the face of the poverty of stimulus, has been essential in the shaping of nativist theories.

First, children can learn any human language within the first few years of life. Children start babbling at about 6-8 months of age, speaking their first words at 10-12 months, and putting words together around their second birthday, and they have mastered most of the grammatical constructions of their language around the age of four and five (e.g. Guasti, 2004; Tomasello, 2003). This is surprisingly early considering the complex and abstract nature of language. In addition, despite the typological diversity of human languages, the overall process of language acquisition is remarkably uniform across languages (e.g. Guasti, 2004; Jackendoff, 1997; Radford, 2004). According to nativist theory, this quick and uniform process is better explained by innate universal principles rather than by environmental factors that vary across individuals, languages and socio-cultural contexts (Guasti, 2004; Hyams, 1986).

A second nativist argument is the argument from the poverty of stimulus. This is the argument that the input is not sufficiently constraining for learners to identify the correct grammar from a range of possible alternative hypotheses (Gleitman & Wanner, 1982; Guasti, 2004; Snyder, and Lillo-Martin, 2011). If we assume that children start the task of language acquisition without any linguistic knowledge, they will face difficulty in restricting the possible hypotheses about grammar because the input language basically provides only positive evidence. For example, it is impossible for a child without any knowledge of phrase structure to identify the rule for forming interrogative sentences in English by only analysing input sentences of different kinds such as '*Is the boy who is smoking crazy?*' and '*Is the girl kissing the boy who is smoking?*' (Ambridge & Lieven, 2011:119). The fact that children learn to produce novel utterances and to judge grammaticality despite the poverty of stimulus is seen as implying the need to postulate innate grammatical knowledge. This is what is called "Plato's problem" (e.g. Chomsky 1975:5, Chomsky 1986), or "the logical problem of language acquisition" (Baker & McCarthy 1981, Hornstein & Lightfoot 1981), which has led

to the view that children are able to arrive at the correct grammar only because they are guided by an innate program (i.e., Language Acquisition Device, LAD, Chomsky, 1965).

In sum, nativist theories seek a model that reduces the child's task to the extent that universally fast acquisition is achievable, even with 'impoverished' input.

2.2.3.2 What is innate and what is learnt?

Children are considered to acquire language from the interaction between inborn factors and the environment. The innate language faculty that guides language acquisition includes UG, which specifies the core features of human language whose components are principles and parameters, rules (operations), categories and phrases (VP, IP etc.). On the other hand, what children learn from the environment, or input language, is the lexicon. Words are language-specific conventions, and are learned and stored in memory, separate from the computational domain of language. Nativist theories, however, do not assume that children also learn higher-level structures from the input. Instead, they assume that language structures (syntax) emerge by setting parameters on the basis of a minimal amount of input. Children's task is to map the language they hear onto their innate grammar.

2.2.3.3 Difference between child and adult grammar

Because nativist theories assume that children have basic structural categories and rules from birth, it is basically assumed that children and adults have the same grammar. This idea is called the Continuity Hypothesis (e.g. Chomsky, 1965; Pinker, 1984). However, children do show errors and usage patterns that are not observed in adult language. These phenomena are accounted for in different ways by different nativist researchers.

The influential Continuity Hypothesis holds that child competence (i.e., grammar) is identical to adult competence (Pinker 1984). This necessarily leads to a performance-based explanation for child acquisition. Children are more likely to make performance errors than adults, and have underdeveloped memory, processing, and articulation capacities.

Another way to explain the difference between child and adult language is to attribute the difference to the mis-setting of parameters. According to this view, children may initially be operating with an incorrect parameter setting, with this parameter setting subsequently being corrected on the basis of exposure to the input language. The implication is that once the child has reset the incorrect parameter setting, her grammar will be the same as the adult's.

A third possibility is that some principles of UG are not available to the child from the beginning and only become available at some genetically determined time. Radford (1990),

for example, argues that children make inflectional errors because they have access only to some major grammatical categories at birth (like nouns and verbs) but not to others such as inflectional categories.

2.2.4 Principles-and-Parameters Theory (PPT)

Principles-and-Parameters theory (PPT), also widely known as Government and Binding Theory (Chomsky, 1981), has been especially influential in the field of language acquisition. This approach was designed to deal with cross-linguistic variation in language structures, which was an issue for the preceding Transformational Grammar, since transformational rules that have been established on the basis of English had difficulty explaining the grammatical structures of other languages. Transformational Grammar included rules for specific constructions, such as the passive transformation, which changed active structure into passive structure. This was a problem for the 'universal' view because different languages would require different rules in order to fit their language-specific structures.

PPT is intended to solve this problem by positing two types of innate constraints: principles and parameters. Principles encode invariant, universal properties that apply to all languages. These principles include Principles of binding, and Principles of control, as well as Principles specifying that language contains lexical and functional categories (such as N, V and Complementiser Phrase (CP), Inflectional Phrase (IP) respectively) (Chomsky, 1982).

Parameters, on the other hand, encode cross-linguistically variable properties. For example, the null subject parameter distinguishes languages that allow null subject constructions in finite clauses, such as Spanish or Italian, and those that do not such as English (e.g., Guasti, 2004; Hyams, 1986). Grammatical constructions in a given language are defined by combining different parameters of this kind, not by a single rule such as the passive transformation. Although there is no consensus about the exact list of specific parameters among researchers, the best-recognised ones include the word order parameter (head-final or not), the pro-drop/null subject parameter, and the V2 parameter.

The distinction between principles and parameters has two important advantages for explaining language acquisition. First, binary (switch-like) parameters that are set on the basis of minimal linguistic experience reduce the acquisition task for the child. Second, they allow a step-wise emergence of syntactic structures because different parameterised rules that are responsible for a specific construction are acquired at different points in development (Hyams, 2008).

According to this framework, the child's task consists of lexical learning and parameter-setting. Principles do not need to be learned because they are innate and invariant. Parameter-setting is done on the basis of a minimal amount of input language, although the theory also allows for the possibility of mis-setting parameters. In order for children to correctly set the parameter from the input, they need to be able to analyse the basic structure of input sentences. For example, they need to segment words from the speech stream and understand, at least, which words are the subject NP and the verb in order to set the word order parameter. PPT thus provides detailed explanations about how children achieve word segmentation and word learning before becoming ready for parameter setting.

2.2.4.1 Lexical learning

PPT assumes that children are able at least to identify words before they begin parameter-setting. This theory has posited different mechanisms that enable children to segment the speech stream and to associate segmented forms with meanings (Guasti, 2004).

The first task is segmentation. Speech is a continuous stream of linguistic sound, and the child has to segment it into word-sized units. PPT basically assumes that segmentation is done by phonological bootstrapping. The basic idea of phonological bootstrapping is that children find the rhythmic or prosodic boundaries only by hearing the sound stream (i.e., acoustic cues) (see Christophe, Guasti, & Nespor, 1997 for reviews). Although this is a kind of statistical learning process which is domain-general, PPT and generativist approaches tend to emphasise the importance of bootstrapping because it supports the idea of quick discovery of linguistic structures in language acquisition. Then children further segment the chunks into words by combining different statistical learning mechanisms. There are three important cues for statistical learning; distributional regularities, typical word shapes and phonotactic constraints. Children are supposed to capture phonetic and phonotactic features and patterns that are observable in the input speech stream (e.g. phonetic sequence [zw] marks word boundaries in English). After segmenting the word units using these cues, there is the task of associating the word units with their meanings. This is explained again by a combination of different mechanisms. Children are assumed to understand the referent of a given word by using word to world mapping, joint attention, and some biases (whole object bias, mutual exclusivity bias, taxonomic bias). Verb meaning is acquired also through syntactic bootstrapping (syntactic cues), in which children use the structure (e.g. 'transfer' type of meaning from ditransitive construction) to guess the meaning of the verb. All these

mechanisms that assist children's lexical learning are not particular to PPT but considered important in other theoretical accounts, including constructivism, to varying extents.

2.2.4.2 Parameter-setting

Having identified the words, children are ready to set parameters that specify the grammatical features of their input language. The parameters are set on the basis of minimal linguistic experience. For example, when children hear an utterance with SOV structure, they immediately set the word order parameter as head-final. As in this example, children are supposed to use only positive evidence for parameter-setting. Chomsky (1981) originally considered positive evidence and negative evidence (correction from interlocutors and non-occurrence), but later Chomsky (1986) proposed the No-Negative-Evidence Hypothesis on the basis of the binary nature of parameters (positive evidence for one setting is sufficient for rejecting the other) (Radford, 2004).

However, in reality, children hear a variety of input utterances and therefore may not hear an utterance that straightforwardly allows the correct setting. For example, the mis-setting of the null subject parameter can occur if children hear an imperative sentence in English before hearing prototypical sentences with an overt subject. But at the same time, the possibility of mis-setting provides a useful explanation for children's usage that deviates from the adult grammar. As Hyams (2008: 194) states, PPT's assumption makes "child language differ in systematic and predictable ways from the adult language". Specifically, this is to assume that children need some time to get the right setting. For example, Hyams (1986) argues that English children start out with the null subject parameter set to the null subject value, which explains why they produce sentences with missing subjects, as if they were following the rules of Italian. Children are supposed to take a while to correct their parameter setting after analysing more input sentences and identifying related grammatical structures. The time required for this resetting is attributed also to the relative complexity of parameter values; the non-null-subject value being considered more complex than the null-subject value.

In sum, PPT has become a representative theory among nativist accounts because of the distinction between principles and parameters that is able to deal with cross-linguistic variation while reducing the complexity of the acquisition task for the child.

2.2.5 Strength and weakness of nativist theories

An important strength of the nativist approach is its ability to generate clear predictions in a principled way. This approach shows how sentences are structured in the

speaker's mind on the basis of abstract rules and categories and also of a definition of competence that is clearly distinguished from performance. The detailed specification of sentence structures as well as that of speakers' state of knowledge provides well-defined predictions for studying children's acquisition. Because of its deductive approach, which contrasts sharply with empirical approaches based on speech data, this approach has stimulated research from a more psychological and computational perspective.

On the other hand, the most common criticisms of nativist theories on language acquisition include their inability to handle developmental change in linguistic knowledge and cross-linguistic structural variation (e.g. Ambridge & Lieven, 2011; Tomasello, 2003).

As has been discussed, developmental change or the difference between child and adult language has been difficult to account for because nativist theories attribute to children highly abstract linguistic knowledge from the outset. The continuity assumption that basic linguistic representations are the same throughout all stages of child language development (Pinker, 1984) helps reduce the difficulty of acquisition, but at the same time, this poses a problem for explaining change. Although different accounts such as maturation and performance limitations have been proposed, these are typically not sufficiently well specified to make clear predictions about the empirical data. For example, it is not clear in what order parameters are set, making it difficult to derive predictions about the difference between child and adult language. The exact set of linguistic universals and parameters in PPT is also unclear. Moreover, given the cross-linguistic diversity that exists in language structures, it is debatable whether absolute universals exist at all (e.g. Evans and Levinson, 2009; Haspelmath, 2007). It is also essential that nativist accounts clarify how innate principles and parameters, or UG, are linked to the actual language children experience (e.g. Tomasello, 2003). On the other hand, some generativist acocunts, especially recent ones, assume the interaction between innate grammar and general cognitive mechanisms such as statistical learning (e.g. Variation Learning Model, Yang, 2004; Legate & Yang, 2007) and cognitive biases (as detailed in 2.2.4.1.) (see Hauser, Chomsky & Fitch, 2002 for a comprehensive discussion). These accounts depart from the original modular idea of language faculty, and instead explore the nature of innate structure which enables, in combination with domain-general learning mechanisms, language acquisition.

2.3 Usage-based/constructivist theories

2.3.1 The History of usage-based theories

Unlike linguistic nativism, usage-based theory did not start with the work of a single researcher, but rather emerged from American functionalism, and evolved by incorporating various related research areas such as cognitive linguistics, exemplar theory and emergentism.

American functionalism is characterised by the idea that grammar and language use are closely connected. This contrasts with traditional linguistics, American structuralism and generative grammar, which keep the two apart. According to Bybee (2010), the first usage-based linguist of the twentieth century was Joseph Greenberg. While he published works on linguistic typology and universals, he studied frequency effects in helping to explain cross-linguistic patterns (Greenberg, 1966). Other key studies in this tradition are those of Givón (1976; 1979), Thompson (1988; 1998), Hopper and Thompson (1980; 1984), Haiman (1985; 2011), Bybee and Scheibman (1999) and Croft (2003), all of which investigated grammar in relation to usage. For example, Bybee and Scheibman (1999) studied the reduction of *don't* in English. They found that the combination of *do* and *not* tends to be reduced in contexts in which it is placed adjacent to the most frequently co-occurring items, which are *I* and certain frequent verbs (e.g. *know*). This phenomenon exemplifies the role of usage patterns in changes in constituent structure; the more two items occur together the more likely they are to be perceived as a chunk or a single unit. What Bybee and Scheibman argued is that speakers' usage shapes grammar. Bybee (2006: 711) later defined the grammar as "the cognitive organization of one's experience with language". Under this assumption, researchers have proposed new ways of looking at language that are not constrained by traditional linguistic concepts.

One of these approaches comes from construction grammar (Filmore, Kay and O'Connor 1988; Goldberg, 1995), which argues that any grammatical structure is a construction that can be understood as a learned pairing of form and its associated semantic or discourse function. Here, 'form' refers to any linguistic unit, from morphemes to phrases, varying in abstractness, from specific items through lexically-based patterns to fully general phrasal patterns. According to Langacker (1987), constructions form a structured inventory of speakers' knowledge of the conventions of their language. This idea: the non-compositional and variable concept of construction, is useful in usage-based theory because it assumes that the psycholinguistic units with which people operate can be identified through observation of their language use (Tomasello, 2000). This is especially well suited to the bottom-up analysis of children's language, and is consistent with the idea that children start by repeating what

their interlocutors have said without being able to analyse it and gradually discover more abstract patterns in the language to which they are exposed.

Another important contribution comes from exemplar theory (Johnson, 1996; Pierrehumbert, 2001). In order to explain variation in the phonetic realizations of a phoneme that cannot be explained in terms of phonological categories, exemplar theory proposed a rich memory for each category which is represented by a large cloud of remembered tokens of that category. These memories are organised in a cognitive map, so that memories of highly similar instances are close to each other, and memories of dissimilar instances are far apart. In this map, frequency information plays an intrinsic role in the system, because it is implicitly encoded by the very nature of the memory system in which frequency and recency of experience result in higher resting activation level for the relevant exemplars (Pierrehumbert, 2001). The idea of direct learning from stored experience, and the process of implicit learning of prototypical exemplars, has been an important inspiration for usage-based theories of language.

In sum, usage-based theories emphasise the view that linguistic knowledge is shaped by speakers' linguistic experience. Because of the strong emphasis on usage, this theoretical view is often contrasted with linguistic nativism, and has generated considerable debate in the field of language acquisition.

2.3.2 Grammar in usage-based theories

The key assumption of usage-based theories is that grammar is not separated from usage. Thus, according to Bybee (2006: 711) "grammar is the cognitive organization of one's experience with language." Tomasello (2000; 2003) characterises grammar as a structured inventory of constructions that results from speaker's accumulated experience with language across the totality of usage events in his/her life. This accumulated experience is shaped by general cognitive learning mechanisms such as entrenchment and abstraction to become conventionalised grammatical knowledge. According to this view, certain aspects of linguistic experience, such as the frequency of use of particular instances of constructions, have an important impact on the way those constructions are represented.

Traditional linguistic categories are defined in a different way in usage-based theory. For example, linguistic units such as words and phrases are not discrete categories but are continuous and variable in the sense that any part of speech can be a psychologically valid unit depending on the pattern of usage (e.g. Bybee, & Scheibman, 1999). Linguistic categories such as word classes (e.g. nouns, verbs), grammatical relations (e.g. subject,

object), or semantic roles (e.g. agent, patient) are also considered as emergent properties in the discourse (Hopper & Thompson, 1984). In addition, structural categories are not discrete but gradient in their abstractness or productivity. Some are fixed structures such as formulaic expressions (e.g. How do you do?), while others are slot and schema constructions (e.g. *NP be*-TENSE *sorry to keep*-TENSE *you waiting,* Pawley & Syder, 1983) or fully abstract patterns (e.g. transitive clause). What determines the shape of grammar is domain-general cognitive mechanisms such as categorization, chunking, rich memory storage, analogy and cross-modal association (e.g. Bybee, 2006; 2010; Pierrehumbert, 2001).

Because of its focus on individual speakers' experience with language, this kind of account naturally allows for individual, social, geographical and cross-linguistic variation in the shape of grammar. This also applies to developmental changes in the linguistic knowledge of language learners. Knowledge is assumed to change little by little as the learners gain more experience with language.

2.3.3 General assumptions about language acquisition

Usage-based theories do not assume any innate linguistic knowledge, though the ability to learn language is considered to be domain-general and innate. The process of language acquisition within this framework is characterised as emergentist, functional and socio-pragmatic (Ambridge & Lieven, 2011). First, acquisition of language structures and categories is assumed to emerge from generalizations over instances of language use. Second, the motivation for acquiring a language is assumed to be functional, that is, based on children's desire to use language and to perform communicative functions. Third, socio-pragmatic processes, such as joint attention, play an important role in learning. All these points make usage-based views distinct from nativist views, which assumes an innate module containing domain-specific knowledge.

The most characteristic feature of the usage-based approach is its emphasis on the role of the input language in shaping linguistic knowledge. On the basis of the input, children use different learning mechanisms and gradually develop their knowledge. Their earliest language is based on the specific linguistic items and expressions they hear and produce. It takes some time for children to categorise or schematise the general structure out of these specific expressions or item-based constructions. Even adult linguistic knowledge is not considered to be completely abstract, but rather an inventory of symbolic resources that includes everything from words and morphemes to whole grammatical constructions,

represented at varying levels of abstractness depending on the distributional patterning of language use.

Children are assumed to use different domain-general learning mechanisms in their acquisition of language. These mechanisms include cultural learning, analogy, and categorization/schematisation among others (e.g. Tomasello, 2003). The following sections describe how these mechanisms work in different stages of language acquisition.

2.3.3.1 Socio-cognitive ability as the basis for language learning

First of all, children are equipped with fundamental socio-cognitive abilities that allow them to learn language. Social-cognitive abilities such as intersubjectivity and intention-reading (theory of mind) are the basis for sharing attention with other persons to interesting objects and events (Bakeman and Adamson, 1984) or for manipulating others' attention (e.g. Bates 1979). Tomasello (1992; 2000; 2003) and Tomasello, Kruger and Ratner (1993) also emphasise the importance of cultural learning which is a form of imitative learning, but is not simply repeating or mimicking the surface form of adult utterances. Rather, it is the attempt by children to reproduce the language adults produce for the same communicative function. According to Tomasello (2003), children as young as 9-12 months start showing these abilities in the form of gaze following, social referencing and imitative learning. In addition to these socio-cognitive abilities, they also take advantage of the world knowledge that they have built up at this point in development.

These socio-cognitive abilities provide a crucial basis for learning, as do more general cognitive skills such as the ability to form concepts and categories, to acquire symbols and their underlying conceptualizations, and to integrate these conceptualizations into larger symbolic wholes (Tomasello, 1992; 2003).

2.3.3.2 The first words

Children's first words can include words from any major word categories: common nouns, proper nouns, verbs, adjectives or even grammatical elements such as articles or case markers. What matters seems to be the function that is associated with these words, from the child's perspective. Children pick up forms that they hear frequently, and these forms become associated with certain contexts in which they occur. These conventions are what children use for regulating their social interactions (Tomasello, 2003).

There is an extensive literature on what the earliest words mean. The main issues include whether these words are bound to particular communicative situations, how children

determine the exact referent of a word from among many possible referents (e.g. Quine, 1960), and how they generalise across instances to build concepts (e.g. Rowland, 2014; Tomasello, 2003). Constructivist views of early word learning assume that socio-cognitive abilities such as joint attention and intention reading play an important role in allowing children to associate forms with their functions in a given context (Tomasello, 2003).

On the other hand, children also need to segment word units from the speech stream. This process is considered to involve statistical learning mechanisms sensitive to the stress and phonotactic and distributional patterns found in the input language (e.g. Echols, & Newport, 1992; Gerken, 2002). At the same time, however, constructivist views do not necessarily assume that children always segment adult-like word units, nor that children have fully segmented their input before starting to produce multi-word utterances.

2.3.3.3 Early multi-word constructions

Children start producing multiword utterances around 18-24 months of age (e.g. Tomasello, 2003). According to Miller and Chapman (1981), English-speaking children's mean length of utterance (MLU) varies between 1.47 and 2.37 at two years of age. At this early stage, however, many of children's utterances are rote-learned holophrases, which are combinations of sound strings and contextualised meanings without any internal structure (e.g. Lieven, Pine, & Baldwin, 1997; Lieven, Salomo & Tomasello, 2009). Among the different types of early multiword utterances, Pine & Lieven (1997) and Lieven et al. (1997) showed that a relatively large proportion of children's utterances can be classified as frozen utterances or instances of lexically-based patterns. These patterns are often based around chunks of one or two words or phrases and have slots into which the child can place a variety of words (e.g. *I can't* + VERB; *where's* + NOUN + *gone?*). Based on the input, and on the similarity between instances that share some aspects of form and meaning, children gradually learn to make substitutions in the slots of these multi-word sequences. These sequences are gradually analysed into their component parts, allowing for greater productivity in their use, which leads to adult-like grammatical knowledge.

Lexically-based patterns represent an important feature of early grammar under usage-based accounts. This feature characterises the non-productive and local knowledge of language structure that is highly dependent on the input language. Tomasello (1992) proposed the Verb Island Hypothesis, according to which children's early knowledge of verbs is metaphorically described in terms of a number of different islands of organization, which are only gradually linked together. Verbs are used in their own unique set of utterance-level schemas, generalised from the observations on what comes before and after the verb,

and later each verb begins to be used in new utterance-level schemas (and with different tense and aspect morphology). Children's verb usage is not generalised across verbs; verbs show individually different developmental timetables which are distinct from how other verbs behave during that same time period. Item-specific patterns are observed not only in early English verbs but also in different domains and languages (e.g. French: Matthews, Lieven, Theakston, & Tomasello, 2007, Hebrew: Armon-Lotem, 2008; and Portuguese: Rubino & Pine, 1998). Although this idea of low abstraction and productivity has been important and characteristic of this theoretical framework, there has been a substantial debate with studies that argued for early abstraction (e.g. Bencini, & Valian, 2008; Huttenlocher, Vasilyeva, & Shimpi, 2004) by showing evidence from syntactic priming in young children.

In sum, the constructivist theory characterises the early grammar by limited productivity and low abstraction with syntactic constructions patterning in lexically-specific ways that reflect the semantic-distributional properties of the input. Although the strong claim of the Verb Island Hypothesis, which is often interpreted as rejecting any abstraction in early language, has been challenged by later studies, its concept continues to be important as this makes a sharp contrast between constructivist and the generativist accounts.

2.3.3.4 The emergence of linguistic productivity

The partial productivity of children's knowledge, characteristically described in terms of item-based constructions, becomes progressively more abstract as children experience more instances of input patterns in a wider range of contexts. But at the same time, constructivist accounts do not even characterise adults linguistic knowledge as fully productive.

Productivity emerges from a process of abstraction over the accumulated experience of usage, and thus emerges gradually and to varying degrees. Bybee (2006) claims that an important source of productivity in grammar is the ability to expand the schematic slots in constructions to fill them with novel lexical items, phrases or other constructions. This process refers to specific sets of items that have been previously experienced and stored in memory, and places novel items in existing pattern, by analogising on the basis of semantic or phonological similarity to stored exemplars (e.g. Baayen 2003, Krott, Baayen and Schreuder, 2001; Bybee, 2006). According to this view, the productivity of a patterns is a function of type frequency because (a) the more lexical items that are heard in a certain position in a construction, the less likely it is that the construction will be associated with a particular lexical item and the more likely it is that a general category will be formed over the

items that occur in that position; (b) the more items the category must cover, the more general its criterial features will be, and the more likely it will be to extend to new items; and (c) high type frequency ensures that a construction is used frequently, thus strengthening its representational schema and making it more accessible for further use with new items (Ellis, 2002: 166).

Highly abstract knowledge is considered to require a considerable amount of input. For example, Savage, Lieven, Theakston & Tomasello (2003) provide evidence from a syntactic priming study for abstract grammatical knowledge about the English active and passive constructions in 6 year-olds, but not in 3-4 year-olds (though see Rowland, Chang, Ambridge, Pine & Lieven, 2012, for counter-evidence to this claim). At the same time, constructivist accounts assume that speakers retain item-based schemas or less abstract knowledge of constructions even after they have acquired constructions at higher levels of abstraction (e.g. Langacker, 1987).

2.3.3.5 Frequency-based organization of language

Input frequency is assumed to be an important factor across a range of different aspects of language acquisition (see Ambridge, Rowland, Theakston, & Kidd, 2015; Ellis, 2002 for reviews). According to the constructivist view, frequency in the input determines the representational strength of particular forms and is hence assumed to affect processing and grammatical acceptability. Many naturalistic studies of children's speech have found that, all other things being equal, the more frequently children hear a particular word or construction, , the earlier they acquire it (e.g. de Villiers, 1985; Naigles & Hoff-Ginsberg, 1998; Theakston, Lieven, Pine & Rowland, 2004). Experimental studies have also provided support for this view by showing that the frequency distribution of constructions in the input is related to children's performance in production tasks (e.g. Räsänen, Ambridge & Pine, 2014), and grammaticality judgment tasks (e.g. Theakston et al., 2004) among others. The effect of frequency on learning and processing is not confined to the early stages of language development. Adult language processing is also sensitive to frequency effects at all levels of language processing (e.g. Bod, Hay and Jannedy, 2003; Bybee and Hopper, 2001; Ellis, 2002), including the speed of word recognition, the ability to recognise similarity to previously experienced events, and categorization (Lieven, 2010).

There are two different types of frequency; token and type frequency. Token frequency is the total frequency with which a form or construction is found in a dataset. High token frequencies can entrench particular items. Each time a word or construction is used, it

activates the mental representation (or 'node' in the network), and this frequent activation is considered to lead to storage of this information as a conventional linguistic unit (e.g. Bybee, 2006; Croft & Cruse, 2004). Relative frequency, which is the proportion or ratio based on the token counts of items is also relevant, especially in the studies on the acquisition of grammatical structures. For example, the frequency ratio between *go* and *goes* can be considered to represent the relative representational strength of these two inflectional forms for the speaker. On the other hand, type frequency refers to the number of different lexical items that occur in a certain pattern or construction. For example, the type frequency of the English past tense inflection V-*ed* is the number of regular past tense verbs in English (Croft & Cruse, 2004). High type frequencies can lead to categorisation via the creation of slots in strings (e.g. Bybee and Scheibman, 1999), and hence to greater productivity (Bybee, 1985; 1995).

2.3.4 Strength and weakness of usage-based theories

An important advantage of usage-based/constructivist approaches is their flexible view of linguistic structure, which does not presuppose the kind of grammatical units, categories or rules that are used in generative linguistics. This is a natural consequence of the definition of language as a cognitive organization of experienced instances of language use. All linguistic structures, from morphemes to complex sentences, and from formulaic fixed expressions to highly abstract patterns, fit into a continuum of 'constructions' that are the pairings of form and meaning with different dimensions and levels of abstractness depending on the pattern of usage. This view gives a straightforward explanation for the variation among different speakers and among languages, as well as for developmental change.

Another strength is their multi-disciplinary nature. They do not assume an innate language-specific module, but try to explain language acquisition by employing different domain-general learning mechanisms from socio-cognitive abilities such as intersubjectivity to statistical learning mechanisms such as category formation.

However, at the same time, the assumption that acquisition is explained in terms of a complex interaction between these mechanisms is a weakness of constructivist theories, not only because of the practical difficulty of explaining how these different mechanisms interact, but also because of the difficulty in generating specific predictions about children's grammar and how this will change with development. One of the challenges for usage-based theories is to incorporate more insights from related fields and to specify how different mechanisms interact to affect the shape of children's grammatical knowledge over the course of

development. For example, how children's lexically-specific schemas develop into more abstract schemas needs to be specified in more detail, in a way that results in clear and testable predictions about children's performance.

2.4 Summary

In sum, nativist and usage-based/constructivist theories reflect fundamentally different approaches toward language, and as a result develop different kinds of explanations and predictions about different aspects of children's language. Regarding the acquisition of grammatical structure, nativist theories tend to predict the presence or absence of certain linguistic phenomenon or to predict order of acquisition in terms of specific grammatical categories and rules. On the other hand, usage-based/constructivist theories characteristically predict input effects, which are often expected to appear in a lexically specific or gradient manner within categories. For example, syntactic processes in nativist accounts apply to all members of a category, while constructivist theories assumes an advantage for often-used lexical items over infrequent ones. This kind of contrast has been investigated in a number of studies. However, more evidence is required from carefully designed studies on a range of grammatical phenomenon across a range of different languages. One area of particular interest is the development of inflectional morphology since the lexical and combinatorial nature of inflectional systems highlights the difference between the two approaches. The next chapter introduces the acquisition of inflectional morphology, with detailed descriptions of some specific topics that are related to the research questions of this dissertation.

Chapter 2: Introduction to the acquisition of inflectional morphology

1. What is morphology?

While some words are single units and cannot be further analysed (e.g. *float*), other words consist of subparts (e.g. *float-ing, a-float*), and we can often find patterns across words which share these subparts (e.g. *float-ing, sing-ing* and *sleep-ing*). Morphology studies words, their internal structure and how they are formed (e.g. Aronoff, & Fudeman, 2011). A word is a complex piece of information, and morphology deals with the systematic pairing of form and meaning at the word level (Booij, 2010:3). Morphology lies half-way between syntax and the lexicon (Bybee. 1985:111), because its focus is on words, but words as structures.

A morpheme is a linguistic concept: the smallest linguistic unit that has a meaning or grammatical function. For example, the word *afloat* consists two morphemes, *a* and *float*, that are the smallest segments with meaning or function. The traditional concern of morphology has been the identification of the "shape" of morphemes, as well as their individual meanings under the assumption that any single morpheme has its own meaning and function (Bybee, 1985). Although a one-to-one mapping of form and meaning or function is not always available (Aronoff 1976; Bloomfield 1933; Booij, 2010; Bybee, 1985; Hay & Baayen, 2005), this concept of morpheme has been widespread and basic in language research.

When a word is segmented into morphemes, these morphemes are often assigned different labels depending on the kind of role they play inside the word. The *root* is the most primitive part of a word that carries its lexical meaning (e.g. *float* in *afloat*). The stem is the part of the word to which affixes are attached (e.g. *kick* in *kicked*). Another definition of the stem is the overlapping part of word across different inflected forms, which applies especially to verbs. Root and stem therefore can be either different or same (e.g. for *spoon-full-s*, the root is *spoon* and the stem can be analysed as either *spoon* or *spoonful*). Affixes are parts of words that attach to the stem such as *–ful* (derivational affix) and *–s* (inflectional affix for number).

There are different formal ways to describe or analyse morphological modifications of words. Some of the most well-known and widely-used analyses are *affixation, vowel change, compounding*, and *fusion*. Affixation is a process of attaching affixes to word stems. Depending on the position to which it is attached, an affix is termed a *suffix* (attached to the end, as in *-less* in *effort-less*), *prefix* (to the head, as in *neo-* in *neo-nate*), *infix* (in the middle), and *circumfix* (to both the head and the end). Vowel-change is a process by which a change in meaning or function of a word involves a vowel change (e.g. *run* > *ran*). Compounding is the combination of self-standing items, as in *ice-cream*. Fusion is when the morphemes are fused

together and not clearly segmentable (e.g. *gonna* < *(be) going to*). This term is also used for inflectional paradigms in which different grammatical functions are accomplished by a single morpheme (e.g. *-ste* in Spanish marks second person, simple preterit tense, and indicative mood).

2. What is inflection?

In order to understand the concept of *inflection*, it is useful to contrast this concept with *derivation* using several different definitions that have been proposed in the literature (while bearing in mind that the boundary is not necessarily always clear-cut).

One of the most wide-spread definitions is that derivational processes create new lexical items, while inflectional processes do not (Kuryłowicz, 1964). For example, *run* and *runner* are different words, and thus classified as an example of derivational change. On the other hand, *run* and *runs or ran* exemplify inflectional changes because these different forms are considered as variants of the word *run*. Greenberg (1954), on the other hand, proposed obligatoriness as a distinctive feature between inflection and derivation. He argued that derivational morphemes can be substituted for some particular class of single morphemes in all instances without producing a change in the construction, as in the case of *duckling* (*duck-ling*) which can be substituted by other nouns (e.g. *turkey*, *cat*) that have no common morphemes. Inflectional morphemes do not allow this. For example, a progressive verb form must be substituted by other progressive verb forms with the same *-ing* morpheme to keep the construction the same (e.g. *The dog is swimming*/*walking*/**walk*). A relatively similar definition is from Matthews (1974) and Anderson (1982) who proposed that inflectional morphemes are those which are required by the syntax of the sentence. Derivations tend to mark semantic modification (e.g. *real-unreal*) as well as to change word classes (e.g. *sing-singer*) whereas inflection generally marks more grammatical distinctions such as tense or case marking (e.g. *walk-walked*).

In sum, inflection is generally considered as a morphological process whereby a word acquires or changes a grammatical feature (e.g. singular/plural, present/past), and typically applies to noun and verb categories among others. Nouns can be inflected for singular/plural distinction, case, and diminutive among other categories. Verb inflection is relatively varied, involving different categories such as person, number, tense, aspect, mood, and polarity depending on the language.

A particular inflectional system in a particular language is often described in the form of a paradigm. A paradigm is a group of related words with a common lexical stem. For

example, the inflectional paradigm of Spanish verbs is often tabulated by person, number and gender, for every tense/aspect and mood categories. Different theoretical views assume different sorts of structured relationships between words. A traditional view regards traditional categorical classifications (e.g. by person, number, mood etc.) as fundamental – i.e., as having some psychological validity – while more usage-based or cognitive views assumes a flexible internal structure in which the relationship between forms is determined in terms of their semantic and phonological similarity (e.g. how similar *write* and *wrote* are semantically and phonologically), which vary as a function – at least in part – of distributional properties of the language (e.g. Bybee 1985; 1988, 1991, Croft & Cruse, 2004; Langacker, 1987).

3. Theories of the acquisition of inflectional morphology

Partly because of the tension between lexical and productive combinatorial aspects of inflectional morphology, how speakers learn and represent morphological information has been an important theoretical question in the field of language acquisition.

Many of the earliest studies on the acquisition of inflectional morphology used naturalistic speech samples, and descriptively investigated the order of acquisition of grammatical morphemes, as in Brown (1973), Cazden (1968), De Villiers & De Villiers (1973). These researchers used the proportion of correct usage of these morphemes in obligatory contexts (e.g. 90%) as a criterion for "acquisition", and investigated the order of acquisition, and whether this is explained by different factors such as MLU (mean length of utterance), age, grammatical complexity and frequency of use. Studies adopting a more functionalist viewpoint investigated the relationship between cognitive and language development. For instance, Antinucci, & Miller (1976) is a corpus study that focused on the cognitive development of temporal notions in Piagetian terms (Piaget, 1954; 1971), and on children's linguistic expressions using Italian past tense inflection. Another important approach is experimental. Berko (1958) tested children's productive use of (amongst others) English past and plural inflections with nonce-word a sentence completion paradigm that has since become known as the "wug test" (e.g. "*This is a wug. Now there is another one. There are two of them. There are two ...*"). Such methods have provided more direct evidence regarding children's productivity with inflectional morphology, as well as the difference in productivity between child and adult linguistic knowledge. Other experimental studies with similar elicitation methods include Miller & Ervin's (1964) longitudinal experimental study

of children's production of plural inflection, and studies of the effect of phonology on children's plural inflection (e.g. Anisfeld, Barlow and Frail, 1968; Solomon,1972).

More recent literature has tended to focus on distinguishing between the two theoretical approaches, nativism and usage-based theory/constructivism, that have proposed different accounts for the acquisition of inflectional morphology. The following sections introduce the basic views on verb inflectional morphology and on children's acquisition of this domain of language from these different approaches.

3.1 Nativist approach to the acquisition of inflectional morphology

3.1.1 Inflectional morphology in nativist approach

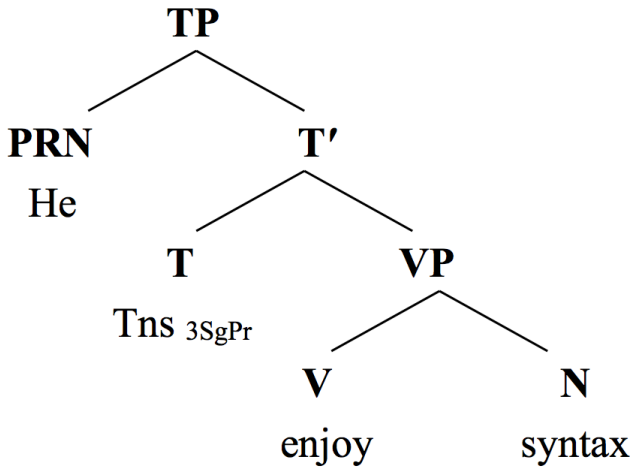
In nativist theories, morphology does not have its own "module" but concerns both the lexicon and syntax. Although there are different views regarding the extent to which morphological processes should be considered as the domain of the lexicon versus the grammar (syntax) (Marantz, 1997), the mainstream nativist position (e.g. Pinker, 1999) is that regular inflectional morphology is part of syntax, and is to be explained in terms of syntactic categories and rules. This section summarises the basic approach of Principles and Parameter Theory (PPT) and its descendent the Minimalist Program; a view of the acquisition of verb inflection that has been influential in the nativist literature.

This approach generally assumes that speakers are innately equipped with categories such as INFL (inflection), TNS (tense) and AGR (agreement), in addition to principles and parameters. INFL includes not only functional words such as auxiliaries (e.g. *is, was, has, had*) but inflectional morphemes such as the past-tense *-ed* and present-tense *-s* verb markers (e.g. Ambridge & Lieven, 2011;110), in the case of English. Tense (TNS) and Agreement (AGR) are sometimes included under the concept of INFL, otherwise discussed separately when specific distinctions are needed (e.g. Wexler, 1998). Speakers with this generative knowledge are assumed to be fully productive with inflection, or in other words, to be able to apply any inflection (that they know) to any verb (that they know).

The representation of inflectional morphology in sentences is explained by recursive use of the *merge* operation. In general, any clause is formed by successive binary merger operations, each of which combines a pair of constituents to form a larger constituent. Regardless of the formal means (e.g. suffixation, vowel change etc.), INFL usually merges with the Verb Phrase (VP) and generates an Inflectional Phrase (IP) (or with the Agreement and Tense phrases), which will then be included in an even higher structure Complementizer Phrase (CP). The verb checks its inflectional marker when VP merges with INFL. This

operation specifies not only tense and/or the agreement of person or number on verbs, but also inflection on nouns where required for the syntactic structure (e.g. nominative case markers). Radford (2004) shows an example of a finite tensed clause *He enjoys syntax* (see Figure 1) which is formed by merging the noun *syntax* with the verb *enjoy* to form a verb phrase (VP) *enjoy syntax,* then this verb phrase merges with Tense constituent to make this an intermediate projection (T') *enjoys syntax*. The final merger is between this constituent and pronoun *he*, creating the tensed phrase (TP) *He enjoys syntax*.

Figure 1. Syntax phrase structure of the sentence *He enjoys syntax* (Radford, 2004: 117)



In terms of the actual production, the morphological process takes place in the PF (Phonetic Form) component. Once the syntax has formed a clause structure (the structure often described as a tree), the relevant syntactic structure is then sent to the semantic component to be assigned a semantic interpretation, and to the PF component to be assigned a phonetic form. It is in this final PF component that a number of morphological and phonological operations are applied to lexical items (Radford, 2004).

Another important aspect of the nativist approach is the distinction between regular and irregular inflection. The functional category INFL includes inflectional morphemes (e.g. past-tense *-ed*) and functional words that are used to mark inflection (e.g. auxiliary *HAVE*/*BE*), but does not include irregular forms (e.g. *made*, *went*). Irregular forms are stored in the lexicon, and retrieved as whole lexical units. At the same time, however, irregular forms differ in irregularity; some forms show semi-regularity (e.g. *keep/kept, sleep/slept*) while others are totally unpredictable (e.g. *go/went*). There has been an extensive debate over how to account for these different irregular types within the nativist approach (cf. Albright & Hayes, 2003; Chomsky and Halle 1968, Pinker & Prince, 1988; Prasada & Pinker, 1993).

3.1.2 Acquisition of inflectional morphology in nativist approach

In nativist theories, the initial state of children's knowledge of inflectional morphology already includes the basic categories such as INFL (inflection), TNS (tense), and AGR (agreement), as well as general rules about syntactic operations. In addition, children set parameters for their specific language (e.g. whether or not the language marks verb tense syntactically) after a small amount of exposure to the input language. On the other hand, lexical items are learnt from the input. Verb inflection is just one of the syntactic operations computed over the relevant set of lexical items to make a sentence, including the checking of inflection on a lexical verb. As soon as these parameters are set, and the phonological forms of relevant morphemes learned, children are able to inflect any verb that they know. This "full productivity" is an essential prediction of the nativist approach (e.g. Wexler, 1998). Although children are equipped with these categories and rules from birth, they sometimes produce inflection errors. Explaining these errors in terms of rules and constraints, while maintaining the assumption innate linguistic knowledge, has been the major challenge addressed by nativist theories. This section summarises nativist explanations for *root-infinitive* errors and *person-number agreement* errors; two major topics in research on the acquisition of inflectional morphology.

3.1.2.1 Root Infinitive errors

Root Infinitives (RIs) (Rizzi, 1993/4) refer to children's incorrect use of non-finite verb forms in finite contexts. In particular, English-speaking children's errors of using infinitive (bare) forms in place of finite forms have been reported from the earliest literature on the acquisition of inflection (e.g. Cazden, 1968). For example, children sometimes produce errors like **Daddy drink tea* instead of saying *Daddy drinks tea*. This type of error is observed also in other languages. A German example of an RI error is **John Fußball spielen* (e.g. '*John to play football'; rather than the target 'John is playing football'), with an infinitive form *spielen* which is used in the place of the target finite third-person singular present-tense form *spielt* (Ambridge & Lieven, 2011). RI errors have been reported to occur more frequently in some languages (e.g. English) than in other languages (e.g. Spanish), while other languages, such as Japanese, lack RI errors completely. The debate over why children make RI errors, and show crosslinguistic differences in the rates of such errors, has given rise to different hypotheses within the nativist approach.

The small clause hypothesis (Radford, 1996) proposed that children in the RI stage lack functional categories (AGR and TNS), and thus their utterances are only Verb Phrases

('small clauses') that are not fully projected utterances with INFL, as adults' utterances are. This hypothesis has largely been abandoned by current nativist approaches because it cannot explain the fact that children also produce correctly inflected forms in the same developmental period, and the finding that the rate of RI errors differs considerably across languages.

Wexler's account Agreement/Tense Omission Model (ATOM) (Schütze & Wexler, 1996; Wexler, 1998) has been more influential than the small clause hypothesis. This model posits that whilst all functional projections are in place and all parameters correctly set from the earliest observable stage, children optionally omit tense and/or agreement marking in finite contexts. In other words, children's grammar at this stage optionally allows the use of non-finite forms (which is why this proposal is also known as the *Optional Infinitive* hypothesis). The reason that tense/agreement marking is optional is that young children are subject to a Unique Checking Constraint (UCC) which prevents a D(eterminer)-feature on the Determiner Phrase from checking more than one D-feature on functional categories, thus forcing either AGR or TNS to be omitted (Wexler, 1998). Wexler's view is based on the *Very Early Knowledge of Inflection* (VEKI) hypothesis that the child knows the grammatical and phonological properties of many important inflectional elements in their language at the earliest observable stage, and on the Very Early Parameter-Setting (VEPS) hypothesis that the child has set the parameters correctly by the time that (s)he enters the two-word stage at around 18 months of age (Wexler, 1998: 25). On this view, the presence of the UCC is vital for explaining children's productions that are not adult-like. This account explains many crosslinguistic differences in the rate of RI errors because the UCC is "vacuously" applied in INFL-licensed null-subject languages such as Spanish that require no more than one checking of D-feature. According to Wexler, the AGR in these languages is pronominal (for which subjects are unnecessary) and therefore this AGR itself is D, which means that there is no need for checking against some subject D-feature. However, his hypothesis faces problems regarding the existence of non-nominative subjects with correctly agreeing finite verb forms (e.g. **Her plays*), which are predicted not to occur (Pine, Conti-Ramsden, Joseph, Lieven & Serratrice, 2008; Wilson, 2003). It also struggles to explain the *modal reference* effect, that RI errors occur at higher rates for modal meanings (e.g. when the main verb refers to an irrealis event that *may*, *should* or *will* happen) (e.g. Ambridge & Lieven, 2011).

A more successful nativist hypothesis is the Variational Learning Model proposed by Yang (2002), which combines the nativist parametric view with statistical learning. Legate and Yang (2007) claim that children initially have a number of possible grammars (with

different settings of parameters) that compete probabilistically. In terms of tense marking on verbs, children start with both [+tense] and [-tense] options, one of which is to be eventually selected on the basis of input. They argue that the child's underlying grammar in the RI stage is 'a statistical ensemble of potential adult-like grammars (including but not limited to the target grammar), and that is because the morphological system, whose development is frequency sensitive, has not yet driven out the [-tense] option' (Legate and Yang, 2007: 337). This model is more successful than Wexler's (1998) ATOM in that it does not postulate any grammatical constraint that leads to the incorrect prediction of the absence of non-nominative subject errors. It is also more successful at explaining quantitative cross-linguistic variation in rates of RI errors (e.g. Freudenthal, Pine & Gobet, 2010), as a function of the amount of evidence for the +tense grammar present in the input. For example, languages with higher rates of RI error (e.g. English) use a higher proportion of "bare" forms (or forms homophonous with the bare form) than languages with lower rates of RI error (e.g. Spanish). However, the VLM does not explain the modal-reference effect; or indeed any by-verb variation in rates of OI error (e.g. Räsänen, Ambridge & Pine, 2015).

It is also important, particularly in the context of Japanese, to note the nativist concept of the 'RI analogue' proposed by Hyams (2005) and Salustri & Hyams (2003). This concept is based on the observation that even pro-drop (null subject) languages, which basically lack RI errors, show errors that are analogous, or somehow equivalent, to RIs, in that they constitute a formal morphosyntactic "basic" or "default" form (i.e., a form that can be used even when its features do *not* match the person/number features required by the syntax). Forms that have been argued to constitute RI analogues include imperative inflection in Italian (Salustri and Hyams, 2003; 2006), bare perfective inflection in Greek (Hyams, 2005), and past inflection in Japanese (Murasugi, 2015). These inflections are argued to be RI analogues because they show several properties that are characteristic of RIs such as the lack of productive agreement, modal meaning, and restriction to eventive predicates (Hyams, 2005). The RI analogue is a way to extend the concept of RI to languages that are otherwise regarded as non-RI languages, and in fact, different languages have been studied in search of RI analogues in recent years (e.g. Swahili, Deen, & Hyams, 2006; Slovenian and Hungarian, Salustri & Hyams, 2006; Hebrew, Schaeffer & Ben Shalom, 2004). However, the literature on the RI analogue is based mainly on the observations of children's errors and usage patterns rather than on any systematic predictions, and it is not clear whether the RI analogues in typologically different languages are functionally equivalent to RIs. As the RI

analogue is a relatively new concept and has been proposed for relatively understudied languages, there has not yet been sufficient discussion from different theoretical standpoints.

3.1.2.2 Person-number agreement errors

Another (but related) type of error is the *person-number agreement* error whereby children produce inflectional forms that are not correct in the given person-number context. For example, Gathercole, Sebastián, & Soto (1999) report examples in child Spanish in which a third person singular (hence 3sg) preterit *cayó* '(it/he/she) fell' is used instead of the target third person plural (hence 3pl) present perfect form *se han caído* '(they) have fallen'.

The basic generativist assumption is that children rarely make errors, provided that all of the relevant inflections have been learned (e.g. Wexler, 1998). Hoekstra and Hyams (1998) supported this prediction by reporting that rates of person/number-marking errors (when finite forms were used) were very low (less than 4%) in all the languages they reviewed: Italian (Guasti, 1994; Pizzuto & Caselli, 1992), German (Clahsen & Penke, 1992), Spanish and Catalan (Torrens, 1995). These findings are considered as evidence for "very early knowledge of inflection" (Wexler, 1998), and for innate knowledge of the abstract functional categories (AGR and TNS).

As for theories of RI errors, the mechanism by which person-number agreement errors occur has been argued to be (a) lack of adult-like grammatical categories (Small Clause Hypothesis, e.g. Lebeaux, 1988; Platzack, 1990; Radford, 1990) or (b) a full set of categories that is either incompletely or incorrectly specified (e.g. Bloom,1993; Grinstead, 2000; Hyams, 1986 ; Valian, 1991).

The former view assumes that children's language includes only a subset of the adult's grammatical categories. Radford's (1990) Small Clause Hypothesis, as mentioned above, is also applicable here. Radford argues that children are born with innate lexical categories such as Noun and Verb. However, functional categories like Determiner, Complementizer, and – crucially – Inflection mature or come on-line later than lexical categories. Consequently, children lack not only inflectional elements but the movement/merge processes necessary to apply them. Thus person-number agreement errors, as well as other types of inflectional errors such as the omission of auxiliary *do*, are due to the lack of maturation of the Inflection category according to this view. Although this hypothesis has been popular once, it has received criticism from other generativist views like Poeppel & Wexler (1993) who pointed out the absence of functional categories is not capable of explaining children's utterances that simultaneously show both grammatically correct and

incorrect structures of, for instance, agreement and word order. In addition, this hypothesis has problem explaining the crosslinguistic differences in children's error rates. Due to these issues, the Small Clause Hypothesis is no longer frequently discussed in the field.

A different approach is proposed by Hoekstra and Hyams (1995; 1998), who argue, on the basis of their studies of RI and non-RI languages, that what might be missing or underspecified in early grammar is number (rather than person or tense). This claim is based on the idea that the underspecification of number has cross-category effects of leaving the determiner phrase (DP) underspecified. Underspecified DPs parallel RIs in that they lack a D-chain, and therefore yield grammatically unanchored structures, to which normal checking procedures cannot be applied (Hoekstra & Hyams, 1998). On this view, what divides RI and non-RI languages is number specification; RIs occur only in languages where the expression of finiteness may be done exclusively through number morphology, and not in languages where finiteness is always expressed with person agreement, or with tense-morphemes (Hoekstra & Hyams, 1998: 87). For example, according to these researchers, a present tense finite verb in Dutch is morphologically marked for singular or plural, but not for either person or tense, meaning the finiteness is marked by number. In languages like Italian, Spanish and Catalan, on the other hand, this is done by (at least) person morphology. This hypothesis thus claims that children's person-number agreement errors reflect the interaction between the underspecification of Number and the type of grammar regarding finiteness of the language in question.

Grinstead (2000), in a similar vein, proposes that the contrastive use of Number and Tense is inactive in early grammars, and that this is linked with the absence of overt subjects. He claims that contrastive Tense and Number always arise later than does contrastive Person on the basis of his corpus analysis of child Spanish and Catalan, in which tense and number verbal morphology was not used contrastively in the early stage (e.g. *Se cayó*! (3sg form) 'it fell' in the context of pointing at two or more plastic animals, Grinstead 1998). He concludes that Tense and Number Phrases do not form an active part of the clause structure of these languages in early stages, in contrast with the Person Phrase, which appears to be active from the very beginning. The accounts of Hoekstra and Hyams (1995; 1998) and of Grinstead (2000) seem again to lack an explanation for how children produce both correct and erroneous forms in the same developmental period. In addition, some studies have shown that their categorical predictions regarding children's use of inflections, such as the early active Person feature, do not hold (e.g. Aguado-Orea & Pine, 2015, Gathercole, et al., 1999).

Another well-known class of accounts is that of "performance" accounts. This approach assumes that young children have a fully specified grammar, but that this may not be apparent on the surface level because of performance constraints such as memory limitations, processing load, prosodic characteristics, and discourse factors. Children's memory span is correlated with their MLU (Blake, Quartaro, Austin, & Vingilis, 1989), and is limited compared to adults' memory. The inferior memory results in the production of shorter utterances or shorter constituents within the utterances that sometimes result in errors (e.g. omission of auxiliaries, resulting in OI errors in English and other Germanic languages). For example, Bloom (1990) explained children's early inconsistent use of subjects in terms of performance limitation by showing, from his corpus analysis, that children's verb phrases were longer when a subject was absent than when it was present, as would be expected if children were operating under performance limitations (Valian, 1991:32). Performance factors, however, need to be combined with other factors, such as the content of the message, syntactic and discourse requirements, in order for account to predict specific patterns of error in child language (Valian, 1991).

In sum, generativist accounts for RI and for person-number marking errors have similar principles: Children have a certain constraint like the UCC or lack some grammatical categories such as Number in the early stages, while all other rules and categories are in order for productively generating sentences with inflected verb (and noun) forms. These accounts therefore predict categorical patterns in children's inflections; a prediction that has not been supported by studies that showed by-verb differences in error rates or correct-usage patterns (e.g. Aguado-Orea & Pine, 2015; Pine et al., 2008; Räsänen et al., 2015; Wilson, 2003). However, it remains possible that either – on the one hand – apparent productivity or – on the other – apparent lexical specificity is an artefact of sampling (e.g. Rowland & Fletcher, 2006; Valian, Solt & Stewart, 2009). This sampling problem underlines the need to shift to more quantitative and systematic analyses, instead of more descriptive and intuitive analyses based on small speech samples.

3.2 Usage-based/Constructivist approach to the acquisition of inflectional morphology

3.2.1 Inflectional morphology in usage-based/constructivist approach

Usage-based/constructivist theories consider inflection not as a fixed category but as a generalization that results from the repeated experience of instances of closely related words. Input-based lexical learning constitutes the basis for later pattern-detection and abstraction of morphological schemas. A productive inflection is simply a schematic representation that is

relatively highly entrenched (Croft & Cruse, 2004). Morphological relations, including inflection, are emergent from words that show semantic and phonetic similarity (Bybee, 1985; 1988, 2010; Croft & Cruse, 2004). For example, English regular past-tense inflection is a generalization over words such as *closed, played and turned*, which share a sound pattern as well as a semantic property. The relationships found among these words is conceptualised as a network with relations of varying strength that reflect differences in both semantic and phonetic similarity. Inflectional categories emerge from the networked knowledge in which the words that serve the same function in utterances and constructions are gradually grouped together (e.g. Tomasello, 2003).

Another characteristic assumption of usage-based approach is that a particular generalization co-exists with the representation of less abstract (more concrete) schemas and even individual instances (i.e., stored exemplars). Even if a speaker has the generalised category of past inflection, (s)he is also assumed to have formed a low-level schema such as [CV-*zd*] and to retain the individual forms like *closed*. In fact, the more specific schemas are considered more basic in this approach (Dąbrowska, 2006; 2008), because the essential distributional information is supplied by lower-level schemas and specific instantiations for many constructions (Langacker, 2000). This redundant representation is based on the assumption of a rich memory for language, which is supported by a range of evidence regarding the storage of many regular expressions of different kinds, even including high frequency regularly inflected forms (Baayen, Dijkstra, & Schreuder, 1997; Schreuder, de Jong, Krott, & Baayen, 1999; Stemberger & MacWhinney, 1988). For example, Baayen et al. (1997) conducted a visual lexical decision task about Dutch plural suffix *-en* and argued the full-form representation of high frequency plural (regularly inflected) nouns on the basis of the effect of surface frequency (number of tokens of plural inflected forms) on the response latency of these forms.This approach does not make a clear distinction between regular and irregular inflections. The same learning or processing mechanism is applied to both, with the only difference being the degree of schematicity or productivity (e.g. Bybee, 2010). This idea of a single mechanism is common also in cognitive linguistics more generally (e.g. Bybee, 1995; Croft & Cruse 2004; Langacker, 1991, 2000), and most connectionist models (e.g. Rumelhart & McClelland, 1985; Plunkett & Marchman, 1993; Elman et al., 1996).

3.2.2 Acquisition of inflectional morphology in usage-based/constructivist approach

The usage-based/constructivist view predicts input-based learning of whole forms and a gradual development of abstract inflectional knowledge. Children initially acquire whole

inflected forms without figuring out their internal grammatical or morphological structure. They then "recognise" (not consciously, at least at first) some similarities that are shared among memorised instances of inflected forms, which is the beginning of the acquisition of abstract inflectional patterns. At this stage, the generalization is limited, and children's knowledge of inflection is characterised as highly item-based (e.g. Lieven, 2010; Tomasello, 2000). A child might know, for instance, the past-tense form for *walk,* but not *skip*. As the Verb-Island hypothesis (Tomasello, 1992) posits, inflectional knowledge is considered to be bound to specific verbs, or to group of verbs that the child is familiar with, and not extended generally across verbs. After this stage, the similarities are reinforced through repeated use and this results in the extraction of low-level schemas (Dąbrowska & Szczerbinski, 2006). Speakers may also develop more general construction schemas by integrating different low-scope schemas (Ambridge & Lieven, 2011). The original function of schemas is to capture redundancies in the lexicon (i.e., if a form cannot be retrieved for whatever reason, it can be generated using a schema); however, once they become well-established, schemas can be used to inflect novel words (Dąbrowska & Szczerbinski, 2006: 561).

This productive use (for example, in experimental "*wug*-tests") is explained in terms of analogy, whereby children create a new inflectional form on the basis of previously experienced inflected forms. The greater the number of lexical items that follow a particular pattern, the greater the availability of that pattern for analogical application to new items (e.g. Bybee, 2010). For instance, the English past-tense inflectional pattern for *sleep*/*slept* and *keep*/*kept* is not used for many verbs, and thus children are not very likely to apply this pattern to new verbs. In contrast, the regular *–ed* suffix is easily applied or even overgeneralised (e.g. Marcus et al, 1992; Maslen et al, 2004). At the same time, however, this approach does not assume across-the-board productivity for any particular morphological construction, but predicts some lexical effect or gradience in the distribution or acceptability across forms with the same inflection. Moreover, this approach recognises the importance of prefabricated patterns, semi-fixed and fixed expressions that abound in our actual language use (e.g. Wray, 2005).

Frequency of use plays an important role in the learning of inflection. Token frequency of an inflectional pattern entrenches the construction while token frequency of inflected forms increases the strength of the representation of the whole forms, thus making them easier to process and retrieve. On the other hand, type frequency of an inflectional pattern, namely the number of lexical items the pattern is used with, affects productivity: Patterns which apply to a large number of items should be easier to generalise, and thus

acquired earlier (Dąbrowska, & Szczerbinski, 2006), while patterns with a low type frequency are more idiosyncratic, and less likely to be used for analogical learning.

Children's errors, or patterns of usage of inflection that deviate from the adult grammar, are explained by the frequency distribution of the input, as well as by other factors such as phonological regularity and position in the utterance. The following sections summarise the usage-based/constructivist accounts of the two types of errors discussed above for the nativist approach.

3.2.2.1 RI and Person-number agreement errors

Usage-based approach assumes that productions without required inflectional markings are directly learned from the input through probabilistic learning mechanisms. Different inflectional forms of a verb are used with different frequencies in the input language; for instance, *sing* is more frequent than *sang* and *sings*. The relative frequency of these forms (i.e., proportional frequency or ratio) is considered to reflect the probabilistic competition between these forms at representational level (e.g. Ambridge et al, 2015). Because of its frequent occurrence in the input, children are assumed to learn *sing* earlier than *sang* or *sings*. With regard to RI errors, the prediction that follows is that children are likely to retrieve *sing* more easily compared to *sang* and *sings*, and therefore to overuse *sing* when they have difficulty accessing *sang* or *sings*, yielding RI errors such as **He sing well*. Verbs with a lower ratio of bare to inflected forms (e.g. fit) are less likely to yield RI errors (e.g. **That fit in there*) and more likely to be used correctly (e.g. *That fits in there*).

Consistent with this prediction, Räsänen et al., (2014) investigated children's RI-type errors of using bare/nonfinite forms in contexts that require finite forms in English (e.g. **Daddy drink coffee* for *Daddy drinks coffee*), and found that the by-verb error rate in an elicited production study was explained by the proportional frequency of the test verbs in bare versus 3sg -s forms in child-directed speech. That is, children are more likely to make this kind of errors for verbs that are frequently used in bare/nonfinite forms including auxiliary or modal verb constructions such as *He should play* or *He wants to play*. An important innovation of this study, as compared with most in the RI literature, was its investigation of the input frequency distribution *at the item-based lexical level*. The ability to explain the patterning of errors at the lexical level constitutes a particularly powerful test of rival theories; and this is therefore an approach adopted extensively in this thesis.

Another approach for understanding the mechanism behind person-number agreement errors is computational simulation. MOSAIC (model of syntax acquisition in children) is a

model that incrementally learns input utterances from samples of actual child-directed speech, and produces longer utterances as it proceeds (Freudenthal, Pine, Aguado−Orea & Gobet, 2007; Freudenthal, Pine & Gobet, 2006; 2010). This learning mechanism gradually builds up the representations of sentences from the right edge, based on the assumption that children are particularly sensitive to items in utterance-final position (i.e., a recency effect in memory, Davelaar, Goshen-Gottstein, Ashkenazi, Haarmann, & Usher, 2005; Greene, 1986). MOSAIC can yield RI-like sentences because processing input sentences like *He can go home.* with the utterance-initial (which was introduced in Freudenthal et al., 2010) and -final bias can generate an output like *Go home* and *He go home* (RI-like). On the other hand in Spanish, a non-OI language with null-subject feature, RI-like sentences are not generated from sentences that lack an overt subject as the RI-like sentences are characterised by the combination of a subject and a non-finite verb, which leads to the low rate of errors in this language. This model has been successful in simulating the relative rates of RI errors across five different languages (English, Dutch, German, French and Spanish), and shows that this phenomenon is best explained in terms of the interaction between the utterance-final bias in learning and the distributional characteristics of child-directed speech (Freudenthal et al., 2010).

Not only these RI type errors but also different types of person-number marking errors have been explained in terms of the frequency distribution in the input. The naturalistic-data studies of Aguado-Orea & Pine (2015) and Rubino & Pine (1998) revealed differences in the error rate across the verb paradigm in Spanish and Brazilian Portuguese respectively. In Spanish, the vast majority of children's person-number marking errors (about 80-90%) involved the use of a third person singular form in a non third person singular context (Aguado-Orea & Pine, 2015). This distribution of errors is explained by the fact that third person singular forms are considerably more frequent than other person-number forms in the input. (Though another possible explanation is that the third person singular inflection is phonologically prototypical in the paradigm). This study therefore showed that the distributional pattern of errors suggests an input-based defaulting process, whereby children default to the most accessible form (due to either frequency and phonological factors) in the input when they have difficulty retrieving a target form.

The erroneous use of a high frequency form in lower-frequency person/number contexts was also observed in a study of Finnish verb inflection (Räsänen et al., 2015). The findings from this elicitation study included not only an effect of the frequency of person number contexts (e.g. 2sg) but also – crucially – of individual inflected forms (e.g. *sanot* 'say (2sg)') on young children's (2;2-4;8) rates of correct production (and, conversely, errors).

This suggests the importance of not only relatively abstract schemas (for person/number forms), but also of the direct learning of inflected forms from the input. In addition, high phonological neighborhood density was shown to help children avoid errors with low frequency verbs, suggesting the importance of analogical learning.

In sum, the literature reviewed above suggests at least preliminary support for the usage-based prediction that children's knowledge of inflectional morphology reflects the frequency distribution of whole inflected forms (and, perhaps as a consequence, of person number context). Although input frequency is the most commonly investigated predictor under a constructivist approach, this approach also incorporates – at least in principle – a role for other learnability factors such as phonological characteristics, phonological neighborhood density, morphological regularity, semantic complexity and position in the sentence (e.g. MOSAIC). A challenge for the constructivist approach is to include these different factors, both linguistic and general cognitive factors, in order to model the complex learning process of language. In doing so, it is crucial to carefully deal with the confounded nature of these factors. Apparent effects of input frequency have been observed in many studies, but only a limited number of these studies have controlled for confounds such as those caused by sampling effects (Rowland & Fletcher, 2006; Tomasello & Stahl, 2004) and correlations between frequency and morphological/phonological complexity. A further challenge for this approach is to move beyond showing early effects of lexical specificity and to provide an account of exactly how more abstract, productive representations develop.

3.3 Problems in distinguishing the theories of the acquisition of inflectional morphology

Nativist and constructivist theories offer contrasting accounts of how children acquire inflectional morphology. Inflection, under nativist theories, is one of the usual syntactic operations used to form a sentence from lexical items and is defined in terms of categories and general rules. On the other hand, constructivist accounts view inflection as a generalization across instances of related forms that develops through input-based learning. One of the most distinguishing contrasts between these theories is their predictions relating to the productivity or otherwise of children's inflectional morphology. Nativist accounts assume full productivity, whereby children can inflect any verb in their lexicon using general categorical operations (at least once they have properly set the parameters and acquired the phonological forms of the necessary inflections). Constructivists assume partial productivity that gradually develops on the basis of lexical learning and subsequent gradual generalization. A number of studies have attempted to test these contrasting accounts, using corpus-based

and/or experimental methods. However, these studies have yielded some supporting evidence for both of these approaches (e.g. Aguado-Orea & Pine, 2015; Guasti, 1994; Hoekstra and Hyams, 1998; Pizzuto & Caselli, 1992; Räsänen et al., 2015), and distinguishing them has been difficult because of, in particular, two methodological and language-specific issues.

The first issue is that studies using children's naturalistic speech samples need to (but in many cases do not) take into account sampling effects: A frequently used form is more likely to be sampled than a low frequency form, even if both have in fact been learned. Thus many previous constructivist findings of a correlation between input frequency and some measure of acquisition could reflect nothing more than the fact that low frequency forms – even when acquired – fail to be attested in small samples of children's speech. Any true effect of frequency on acquisition can be confirmed only after controlling for this. Frequency is also confounded with other learnability factors. For example, morphological complexity might be hypothesised to negatively affect learning, but is confounded with frequency: High frequency forms tend to be morphologically simple and vice versa. The situation is similar for phonology: High frequency forms tend to be phonologically simple and vice versa. Thus many studies that appear to show an advantage for high frequency forms (e.g. Aguado-Orea & Pine, 2015) may in fact be observing an effect of phonological simplicity. Studies on the acquisition of inflection (or, indeed any phenomenon) must be carefully designed to control out these problems which do not reflect mere experimental "noise" but are inherent in the statistical patterning of the language.

Second, properly distinguishing between different theories requires a wide range of languages. The field is considerably biased towards major European languages. A considerable amount of work has done especially on RI- and person-number marking errors in English, and, to a lesser degree, in other European languages such as German, Dutch and Spanish. These well-studied languages are genetically related and share many features of language structure. Given the crosslinguistic diversity not only in the structural aspects but also in socio-cultural aspects, this bias in the field is a problem: Theories of language acquisition are meant to cover all human languages, and thus need to be examined using a set of typologically different languages. At the same time, it is also important to study languages that have specific properties to distinguish different theoretical predictions. For example, in English, the bare (infinitive) form is the most frequent and phonologically simplest form of – almost certainly – every verb. This feature is not ideal if we want to study the effect of frequency or phonological simplicity on children's errors because these two factors are

difficult to separate. One possible solution to this problem is to study languages in which the most frequent forms are not always the phonologically simplest forms.

In consideration of these methodological and language-specific issues, the current dissertation focuses on Japanese, a language that allows for the comparison of different theories by virtue of its rich inflectional morphology and its probabilistic characteristics in the use of different inflectional forms at the verb level. That is, in Japanese, the relative frequency of – for example – past vs nonpast, simple vs complex-completive and simple vs complex-stative forms varies on a verb-by-verb basis. It is this particular property of Japanese that makes it especially useful for testing nativist and constructivist accounts of the acquisition of inflectional morphology, while controlling for the potential confounds identified above.

Chapter 3: Introduction to the acquisition of inflectional morphology in Japanese

Japanese is a language spoken almost exclusively in Japan with a speaker population of about 128,000,000 (Ethnologue, https://www.ethnologue.com/). It is characterised as isolated language because of the absence of any genetic relationship with other languages. Japanese is used as the main language in almost all contexts in Japan, including infant to high-level education, media such as TV, radio and internet, both written and spoken. Although Japanese shows considerable dialectal variation, the grammatical description in this chapter is based on Tokyo dialect which is often treated as 'standard' (and which is used in all of the studies reported in this thesis).

The first part of this chapter introduces the basic linguistic characteristics of Japanese, with a focus on inflectional verb morphology. The second part of the chapter summarises the literature on the acquisition of Japanese and contextualises the specific topics that are discussed in the current dissertation.

1 General description of Japanese grammar and morphology

1.1 Grammatical features of Japanese

1.1.1 Phonology and transcription

The Japanese phonological inventory consists of five vowels /a,e,i,o,u/ and fifteen consonants /p, t, k, b, d, g, s, h, z, r, m, w, j, N, Q/ (y is used for the transcription of /j/). For vowels, short and long vowels are distinguished for all 5 phonemes. /N/ and /Q/ are the only consonants that can close a syllable, and their phonetic realization varies depending on the following segment (e.g. /saNma/ [samma] and /saNdo/ [sando], /biQkuri/ [bikkuri] and /piQtari/ [pittari]). Japanese has a pitch accent system that distinguishes high and low pitch. Words have individual pitch accent patterns that are specified on the mora level (e.g. *ko.to.ba* Low.High.High 'word').

The use of mora as suprasegmental unit is a characteristic aspect of Japanese phonology. A mora is a unit that segments the speech sound in terms of duration (a syllable is defined by the phonological structure), and consists of CV or C (only /N,Q/) in Japanese. Each mora can be represented by one Japanese character (e.g. 3 moras for *sa.N.ma* さんま, 4 moras for *bi.Q.ku.ri* びっくり). Mora functions as a rhythmic unit in poems, word games and so on.

1.1.2 Morphology

Japanese morphology is often classified as agglutinative because of the abundance of affixation processes. The most complex morphology is observed in verbs that can take multiple suffixes within a word. Finite verbs are always inflected for tense, and optionally for other categories such as aspect, polarity, and politeness. Japanese verbs exhibit no agreement with nominal arguments. In addition, verb forms change also depending on the type of following constituents such as coordinated clause and auxiliary verbs (verb inflection is described in more detail in the following sections). Auxiliary verbs and adjectives are similarly inflected for different categories. A more detailed description of verb morphology is given in 1.2.

Nouns are often used with postpositional case-marking clitics, though these clitics can be left unexpressed, especially in spoken language. These case markers include nominative (*ga*), accusative (*o*), dative (*ni*), genitive (*no*) and locative (*de*). In addition, a topic marker (*wa*) may be used in place of case markers depending on the discourse-pragmatic context. There is no number or gender inflection, and no determiner.

Regarding word formation, affixes and compounding are commonly used (e.g. *o-mizu* (POLITE-water) 'water'; *mizu-kusa* (water-plant) 'waterweed'). Verbs also show compounding of different kinds, from lexically-specific combinations to grammaticised patterns (e.g. *hasiri-nuke-ru* (run-pass.through-NONPAST) 'run through', *hasiri-das-u* (run-put.out-NONPAST) 'start running').

1.1.3 Syntax

Japanese is a typical head-final language, with features such as verb-final word order, attributive-noun word order (including relative clauses before their head noun), and the use of postpositional case markers. The basic word order is SOV, but the order of nominal arguments is pragmatically conditioned and relatively free in spoken discourse — a phenomenon often referred to as 'scrambling' (see Shibatani, 1990). For example, compared to the typical SOV order as in *Maki ga Ken o tatak-u* (Maki-NOMINATIVE Ken-ACCUSATIVE hit-NONPAST)) 'Maki hits Ken', OSV order as in *Ken o Maki ga tatak-u* (Ken-ACCUSATIVE Maki-NOMINATIVE hit-NONPAST) can be interpreted as more object-focused . In addition, nominal arguments are frequently left unexpressed especially in colloquial speech (e.g. *Maki ga tataku* 'Maki hits (X)' and *Tataku* '(X) hits (Y)' are grammatical). Japanese exhibits no agreement relationship between arguments and verbs. Instead, case marking clitics on noun phrases play an important role for indicating semantic

roles and grammatical relations, though they are not obligatory and are frequently omitted, especially in colloquial speech. Because of these characteristics, "Japanese grammarians in general assume that noun phrases corresponding to the subject, the direct object, and the indirect object are all complements of the verb and are related to the verb on a par" (Shibatani, 1990: 281). This contrasts with languages such as English, for which the verb and its obligatory agreeing subject and (for transitive verbs) object arguments are generally held to constitute the core of sentence structure.

Basic sentence structures are made up of (a) noun (with copula verb) predicates, (b) adjective predicates, or (c) verb predicates. Noun predicates basically take the form of a nominative/topic noun phrase + a predicate noun phrase + copula (auxiliary verb) as in *kore wa kawa da* (this-TOPIC river COPULA-NONPAST) 'this is a river'. Adjectives are inflected similarly as verbs *kore wa kawaii* (this-TOPIC cute-NONPAST) 'this is cute'. Verb predicates may take one argument as in *Taka ga ik-u* (Taka-NOMINATIVE go-NONPAST) 'Taka goes', two arguments as in *Taka ga Hide o tataku* (Taka-NOMINATIVE Hide-ACCUSATIVE hit-NONPAST) 'Taka hits Hide', or three arguments as in *Taka ga Hide ni keeki o ageru* (Taka-NOMINATIVE Hide-DATIVE cake-ACCUSATIVE give-NONPAST) 'Taka gives a cake to Hide'. At the same time, the arguments can be left unexpressed and thus are not as obligatory as they are in, for example, English. Even a typically ditransitive verb like *ager* 'give' can be used with fewer than three arguments (e.g. *keeki ageru* (cake give-NONPAST) '(X) gives a cake (to Y)').

Verb predicates show more variation in terms of verb forms and case assignment patterns. Regarding grammatical voice, causative and passive constructions are expressed by causative- or passive-marking on verbs and by noun phrases with case markers that are required by the constructions. For example, an active and passive sentence pair would be *Maki ga Ken o tatak-u* (Maki-NOMINATIVE Ken-ACCUSATIVE hit-NONPAST) 'Maki hits Ken' and *Ken ga Maki ni tatak-are-ru* (Ken- NOMINATIVE Maki-DATIVE hit-PASSIVE-NONPAST) 'Ken is hit by Maki'. Although these word orders are relatively typical for active and passive constructions, the essential grammatical information is marked more by morphological than by syntactic means (hence, as discussed above, "scrambling" of arugments is permitted).

1.1.4 Socio-pragmatic aspects

Despite the basic grammatical structure described above, Japanese linguistic expressions vary considerably depending on the nature of the context and the social status or

role of the speaker and the interlocutor. This section briefly describes two socio-pragmatic dimensions of Japanese; differences between spoken and written speech, men's and women's speech, and polite language.

Sex/gender of the speaker is a dimension of the variation of linguistic expressions. Formal differences manifest in the choice of pronominal forms (e.g. *boku* 'I (male)' *watasi* 'I (female or formal)'), the choice of sentence-final modal particles (such that female speech has a softer and more indirect style, Shibatani, 1990), and more polite forms in females. These gender-based difference emerges early, even in pre-school children's speech (Nakamura, 2001b).

Polite language is a characteristic aspect of Japanese. Japanese distinguishes different registers of politeness that are used in accordance with the speaker-interlocutor relationship, social context, and the type of discourse. Generally, at least four levels are distinguished: honorific-respectful language, formal language, humble language and beautification honorifics (Nakamura, 2001a), in addition to the unmarked plain language. For example, speakers are expected to use formal language in work places in general, in contrast to plain speech at home or with friends, and to switch to honorific-respectful language when they talk to their superiors or customers. Politeness is expressed in different formal ways; polite verb inflection (e.g. plain: *tabe-ru* (eat-NONPAST) vs. polite: *tabe-mas-u* (eat-POLITE-NONPAST)), lexically polite words (e.g. *itadak* 'receive (with humble meaning)'), beautification prefix (e.g. *o-mizu* (POLITE-water)), formulaic expressions and so forth. Proficiency in polite language requires complex understanding of socio-pragmatic distinctions in different contexts, and therefore even adults sometimes have difficulty adjusting their language properly to specific contexts.

Although these variations are pervasive in natural speech, most linguistic theories and studies, including the current thesis, are based on the plain register without politeness markers or modal particles that could mark gender or socio-pragmatic implications. Using this type of plain speech is reasonable given its frequent use in everyday life (especially for speech to and by young children) and its unmarked structures. It is, however, important to bear in mind that the actual language use of a speaker includes a considerable amount of variations in register or style.

1.2 Verb inflectional morphology

Morphologically, Japanese inflection assumes the form of agglutination of the Turkish-type rather than the inflectional morphology of the Latin-type (Shibatani, 1990: 221).

This means that Japanese inflectional suffixes tend to correspond to inflectional categories in a one-to-one fashion, and are easily segmentable (e.g. *-sase-rare-ta* (-CAUSATIVE-PASSIVE-PAST)), which is in contrast with the fusional inflectional system of Latin and of languages like Spanish and Italian which typically mark several different categories by one ending (e.g. *-amos* in Spanish marks 1st person plural, present tense and indicative mood). Japanese suffixes mark verbs for tense, aspect, voice, mood, negation, causation, and semantic relations between clauses such as conditionality (Clancy, 1985:375). Different definitions and classifications of inflectional categories and paradigm have been proposed by researchers, and how to best represent or describe the system is still open to discussion (cf. Bloch, 1946; Kuno, 1973; Masuoka & Takubo, 1995; McCawley; 1968, Sakuma, 1936). The difficulty is partly due to the range of grammatical meanings and functions that are expressed on the verb and its following subsidiary elements that can lead to different classifications depending on theoretical perspective. Table 1 and 2 show one possible classification of verb inflection for a consonant-ending verb stem (*nom-* 'drink') and a vowel-ending verb stem (*tabe-* 'eat') respectively (note that the pattern in Table 1 does not apply uniformly to all consonant ending verbs because of the stem alternations as discussed below). The tables are organised in such a way as to facilitate understanding of the subsequent description and studies within this dissertation (*not* as a comprehensive description of the Japanese inflectional system).

Table 1. Inflectional pattern for a consonant-ending verb (*nom-* 'drink')

FINITE (tensed-marked)		verb	medial markers	tense marker (nonpast/past)	meaning
stem 1	simple	*nom*	-	*u/da*	'drink/drank'
stem 2	negative	*noma*	*na*	*i/katta*	'do/did not drink'
	causative	*noma*	*se*	*ru/ta*	'make/made drink'
	passive	*noma*	*re*	*ru/ta*	'be drunk'
stem 3	desiderative	*nomi*	*ta*	*i/katta*	'want/wanted to drink'
	polite	*nomi*	*mas*	*u/ita*	'drink/drank'

NON-FINITE (not tens-marked)	verb	ending	meaning

independent	cohortative	*nom*	*oo*	'let's drink'
	imperative	*nom*	*e*	'drink!'
	imperative:*te*	*non*	*de*	'drink!'
followed by other verbs/clauses	connective	*non*	*de*	'drink (and…)'
	conditional 1	*nom*	*eba*	'if (X) drink'
	conditional 2	*non*	*dara*	'if/after (X) drink'
	adverbial	*nom*	*i*	'drink (and…)'
	alternative	*non*	*dari*	'drink (and…)'

Table 2. Inflectional pattern for a vowel-ending verb (*tabe-* 'eat')

FINITE (tense-marked)		verb	medial markers	tense marker (nonpast/past)	meaning
	simple	*tabe*	-	*ru/ta*	'eat/ate'
	negative	*tabe*	*na*	*i/katta*	'do/did not eat'
	causative	*tabe*	*sase*	*ru/ta*	'make/made eat'
	passive	*tabe*	*rare*	*ru/ta*	'be eaten'
	desiderative	*tabe*	*ta*	*i/katta*	'want/wanted to eat'
	polite	*tabe*	*mas*	*u/ita*	'eat/ate'

NON-FINITE (not tense-marked)		verb	ending	meaning
independent	cohortative	*tabe*	*yoo*	'let's eat'
	imperative	*tabe*	*ro*	'eat!'
	imperative:*te*	*tabe*	*te*	'eat!'
followed by other verbs/clauses	connective	*tabe*	*te*	'eat (and…)'
	conditional 1	*tabe*	*reba*	'if (X) eat'
	conditional 2	*tabe*	*tara*	'if/after (X) eat'
	adverbial	*tabe*	-	'eat (and…)'
	alternative	*tabe*	*tari*	'eat (and…)'

A basic finite verb form consists of a verb stem and a tense marker as in *tabe-ru* (eat-NONPAST) 'eat' and *tabe-ta* (eat-PAST) 'ate'. Finite verbs are always inflected for tense, which is the only obligatory element. In addition to tense marking, verbs can optionally be

marked with a number of suffixes. These suffixes include aspect (stative/progressive, completive), desiderative, causative and passive, politeness, and negative markers. Consonant-ending verb stems alternate depending on the following suffixes as shown in Table 1. The order of suffixes can be represented as follows, although verbs usually do not take all these elements. Recall from above that, in contrast to English or other major European languages, Japanese verbs do not mark agreement with nominal arguments.

Vstem-causative-passive-aspect-desiderative-NEG-tense
(Shibatani, 1991:307)

Non-finite forms, which do not mark tense inflection, include the imperative, cohortative, connective, and conditional forms, among others. While imperative and cohortative forms are used independently or in utterance-final position (e.g. *tabe-ro* eat-IMPERATIVE 'Eat!', *tabe-yoo* eat-COHORTATIVE 'Let's eat!'), connective and conditional forms basically are usually followed by other constituents in the sentence. For example, connective form is typically followed by another coordinated clause or verb (e.g. *tabe-te non-da* eat-CONNECTIVE drink-PAST '(I) ate and drank.').

Regarding regularity, Japanese verb inflection is generally characterised as highly regular due to the relatively straightforward chaining of morphemes. Regular morphological formation, however, shows several different morpho-phonological patterns. Verbs fall into inflectional classes that are classified in terms of the final sound of the verb stem. The most broad distinction is made between verbs with vowel-ending and consonant-ending stems, which defines the pattern of stem alternation. As shown in Table 1 and 2, vowel-ending stems are constant (e.g. *tabe*), while consonant-ending stems alternate depending on the following inflectional element (e.g. *nom-u* ~*noma-nai*~*nomi-tai*). A further sub-regularity can be made for some consonant-ending stems. For example, the verb stem *kak* 'write' becomes *kai* when followed by certain inflectional suffixes as in *kai-ta* (write-PAST), while the verb stem *kaw* 'buy' becomes *kat-ta* (buy-PAST). This is a language-general phonological phenomenon known as sound euphony (Shibatani, 1990) in Japanese, which leads to different stem alternation patterns within the consonant-ending class. In addition to these phonologically defined regular verbs, there are a couple of irregular verbs that exhibit stem alternation patterns that are not shared with other verbs; *su* 'do', *ku* 'come' and *ar* 'be'.

From a broader perspective, in addition to these morphological variations (at the level of single words), verbs can be followed by auxiliary verbs, combined with other subsidiary

verbs to form a compound/serial verb construction, or complemented by final particles to form a complex predicate phrase. For example, *tabe-te mi-ta* (eat-CONNECTIVE see(SUBSIDIARY)-PAST 'tried to eat') is a serial verb construction in which the subsidiary verb *mi* does not have the original meaning ('see') but a grammaticised meaning ('try to') to modify the main verb. Final particles are attached to the end of sentence (often following a verb) and mainly add pragmatic modal meanings, such as the speaker's attitude toward the information being communicated, and presuppositions about the context and the addressee's state of knowledge (Clancy, 1985). For example, *ka* is a final particle that marks interrogation (e.g. *tabe-ru ka?* eat-NONPAST INTERROGATIVE 'Do (you) eat?'). Other frequently-used final particles include *yo*, which mainly expresses speakers' relative certainty about the truth of the propositions expressed in their utterances (e.g. *tabe-ru yo* '(I) am eating (for sure)') and *ne* which basically asks for admiration, confirmation or agreement from the interlocutor (e.g. *tabe-ru ne* '(I) am eating (is this all right?)') depending on the context and also on the intonation.

1.2.1 Tense marking

Tense is the only obligatory inflection on finite verbs. Two categories, nonpast and past, are distinguished for tense inflection. Nonpast inflection is marked by *–u or –ru* and past inflection by *–ta* or *–da* depending on the final segment of the stem as shown in Table 3.

Table 3. Inflectional forms for nonpast and past tense

	vowel-ending class		consonant-ending class	
	marker	examples	marker	examples
nonpast tense	*-ru*	*tabe-ru* 'eat'	*-u*	*kaw-u* 'buy'
past tense	*-ta*	*tabe-ta* 'ate'	*-ta/da*	*kat-ta*/*non-da* 'bought/drank'

Nonpast inflection is used to refer to both habitual and future events as in *mainiti umi ni ik-u* (everyday sea-LOCATIVE go-NONPAST) '(I) go to the sea everyday' or *asita umi ni ik-u* (tomorrow sea-LOCATIVE go-NONPAST) '(I'm) going to the sea tomorrow', as well as for generic description like *saafaa wa umi ni iku* (surfer-TOPIC sea-LOCATIVE go-NONPAST) 'Surfers go to the sea'. Semantic interpretation differs also depending on the semantic class of verbs; nonpast marking denotes a present state with stative verbs, and future actions or habitual actions with dynamic verbs.

Past forms are used mainly to refer to past events as in *kinoo umi ni it-ta* (yesterday sea-LOCATIVE go-PAST) '(I) went to the sea yesterday'. However, past inflection is also occasionally used to refer to a situation transpiring at the time of the speech, as in *Atta!* 'Here it is!', which is used when a speaker has found something that (s)he had been looking for. This usage can be interpreted as a consequence of the fact that the past marker is historically derived from perfect marker (*-tari*) (Horie, 1997).

1.2.2 Other functions marked on verbs

Other functions that are marked inflectionally on verbs include aspect (completive, stative/progressive), causative, passive, potential, desiderative, politeness, and negation. A verb bearing one or more of these markers in addition to the obligatory tense marker is known as morphologically complex.

Aspectual distinctions on verbs includes completive and stative/progressive aspect (also called perfect/perfective and durative/imperfective by some researchers). Completive aspect expresses the completion of a situation, often referring to a negative implication that happens without the speaker's intention, willingness or responsibility. For example, *tabe-chat-ta* (eat-COMPLETIVE-PAST) 'have/eaten, ended up eating' may refer to a situation in which someone was not allowed to eat something but could not help eating it. Stative/progressive form expresses stative meaning with state verbs (e.g. *mat-te-ru* wait-STATIVE-NONPAST 'wait') and progressive meaning with action verbs (e.g. *hasit-te-ru* run-STATIVE-NONPAST 'be running'). These aspectual markers are diachronically derived from verb + subsidiary construction (e.g. *tabe-chat-ta* (eat-COMPLETIVE-PAST) < *tabe-te simat-ta* (eat-CONNECTIVE end(subsidiary)-PAST); *mat-te-ru* (wait-STATIVE-NONPAST) < *mat-te i-ru* (wait-CONNECTIVE be(subsidiary)-NONPAST)) and grammaticised to the extent that these forms are often segmented as aspectual marking suffixes (Suzuki, 1999).

Causative and passive are also marked on the verb, as in *tabe-sase-ru* (eat-CAUSATIVE-NONPAST) 'make eat' and *tabe-rare-ru* (eat-PASSIVE-NONPAST) 'be eaten'. The passive marker is used also for marking potential. In other words, the same marker is used for a relatively wide range of meanings including passive, potential, honorific and spontaneous (Shibatani, 1985), though other variation is also available in current usage. Therefore, for example, the same form *tabe-rare-ru* can also mean 'can eat'.

The desiderative expresses the intention, willingness or desire to do something as in *tabe-ta-i* (eat-DESIDERATIVE-NONPAST) 'want to eat'. Negation is also expressed on the

verb, as in *tabe-na-i* (eat-NEGATIVE-NONPAST) 'do not eat' or *tabe-na-katta* (eat-NEGATIVE-PAST) 'did not eat'. As these examples show, tense markers take different forms (*-i* for nonpast and *-katta* for past) that are the endings for adjectives (i.e., morphologically a derivation of an adjectival form from a verb, Shibatani, 1990) when the verb is marked for desiderative and negative.

Given the existence of these different different markers, the number of possible inflectional variants of any particular verb is very large. However, not all possible forms are actually used, and the distribution of forms in actual usage varies considerably across verbs.

1.3 The usage pattern of verb inflection

Having surveyed the Japanese verb inflectional system, we now address patterns of usage: Knowledge of how speakers actually use different inflections not only complements the above grammatical description but constitutes essential information for language learning. This section shows the frequency distribution of different inflections from corpus data in order to draw attention on the by-verb and by-speaker variation in the actual usage. Note that the data presented here is only for illustrative purposes and not intended as a description of general patterns.

The frequency distribution of inflections shows considerable variation both across individual speakers and across verbs. Table 4 shows the token frequency of inflections across all verbs taken from two adult speakers' (Nanami's and Arika's mother) all data in the MiiPro corpus of CHILDES (MacWhinney, 2000). The listed inflections are mutually exclusive (e.g. 'nonpast' referes to the simple nonpast inflection, excluding more complex inflections including the same nonpast marker such as 'negative-nonpast'), which holds true for Tables 5 and 6. The most frequent inflections are nonpast, connective and past, followed by imperative, negative nonpast forms and other inflections.

Table 4. Token frequency of inflections across all main verbs in Nanami's and Arika's mothers (restricted to frequent inflections with frequenty 100+)

rank order	inflection	token frequency	rank order	inflection	token frequency
1	nonpast	8328	13	polite-nonpast	341
2	connective	8228	14	potential- nonpast	338
3	past	5577	15	potential-negative-nonpast	303

4	imperative (*-te*)	2259
5	negative-nonpast	1709
6	cohortative	1466
7	stative- nonpast	1226
8	conditional (*-tara*)	829
9	completive past	693
10	conditional (*-ba*)	387
11	gerund	362
12	completive-nonpast	359

16	stative-past	235
17	polite- past	196
18	desiderative-nonpast	182
19	negative nonpast (*-n*)	177
20	negative oblique (*-zu*)	143
21	negative imperative (*-nde*)	111
22	imperative	106
23	potential past	101
24	connective (fused with *wa*)	100

The frequency distribution of inflections varies considerably across individual verbs. Table 5 shows the frequency ratio of different inflections (e.g. token frequency of each inflectional form of a verb divided by overall the token frequency of the verb) for two verbs, *tabe* 'eat' and *hair* 'enter', using the same dataset as Table 4. Both these verbs are often used with the past inflection. However, there are differences as well; some inflections, such as connective are frequent for one verb, but not the other. In addition, the distribution is relatively balanced across the inflections for *tabe* while it is more skewed for *hair*, with two inflections appearing on the majority of tokens. Comparison between Table 4 and 5 suggests that, despite the existence of some generally highly frequent inflections, such as simple past, nonpast and connective inflections, the usage pattern of inflections for individual verb is not the same as the general frequency distribution across verbs but shows item-specific variation. This is a property of the Japanese verb system that is exploited in the studies reported in the present thesis.

Table 5. Frequency distribution of inflectional forms in two verbs (*tabe* 'eat' and *hair* 'enter') (only including relatively frequent inflections)

verb / Inflection	*tabe* 'eat'	*hair* 'enter'
past	17.6%	24.0%
nonpast	15.9%	7.9%
completive nonpast	8.1%	0.5%
connective	7.9%	21.6%

stative nonpast	6.1%	14.2%
negative nonpast	5.5%	5.0%
cohortative	4.4%	1.7%
conditional (-tara)	3.9%	1.0%
completive past	2.2%	1.2%
imperative (-te)	1.8%	1.2%

Variation between speakers is also clearly observed. Table 6 shows the frequency ratio of inflections for the same verb *tabe* 'eat' for two adult speakers (Nanami's and Arika's mothers). These two speakers show different distributional patterns; Nanami's mother uses past inflection more than any other for this verb, whereas Arika's mother uses nonpast inflection almost twice as much as past inflection. Other morphemes such as completive-nonpast and cohortative inflections also show a marked difference among the two speakers. Again, this is a property of Japanese exploited by a number of studies reported in this thesis.

Table 6. Frequency distribution of inflectional forms for *tabe* 'eat' in two adults' data (only including relatively frequent inflections)

speaker / Inflection	Nanami's mother	Arika's mother
past	17.56%	9.80%
nonpast	15.90%	22.88%
completive - nonpast	8.13%	1.31%
connective	7.95%	16.34%
negative- nonpast	5.55%	2.29%
cohortative	4.44%	9.15%
conditional (-tara)	3.88%	2.61%
desiderative- nonpast	3.33%	7.84%
completive-past	2.22%	4.25%
passive- nonpast	2.03%	1.31%
imperative (-te)	1.85%	2.61%

The distributional variation of Japanese verbs is remarkably different from, for example, English verbs, where inflectional distinctions are few and, more importantly, the

bare (infinitive) is the most frequent form across verbs (e.g. for every verb studied by Räsänen et al., 2014; even though half were chosen to be of relatively low frequency in bare forms) and across speakers. This makes Japanese more suitable than languages such as English for studying morphological acquisition at the level of individual verbs.

2. Previous studies of child language acquisition in Japanese

This section summarises the literature on the acquisition of Japanese language structure. The first part of the section introduces the general developmental path of the grammatical aspects of child Japanese and the second part reviews studies on specific topics relating to the acquisition of Japanese verb inflection.

Much of the early literature on children's acquisition of Japanese describes child language from a developmental viewpoint using either tape-recorded data or diary data of children's speech (e.g. Okubo, 1967; 1973; Fujiwara, 1977; Murata, 1961; 1968; Noji, 1974-77; Tanoue, 1979). At the same time, studies of particular topics such as the acquisition of case markers, word order, verb morphology (e.g. Miyahara, 1974; Takahashi, 1975; Yamada, 1980) have explored different specific aspects of Japanese child language. Experimental approaches, with elicitation, acting-out, comprehension and imitation among others, have also been used for studying these topics (e.g. Hakuta. 1981; 1982; Hayashibe, 1975).

More recent literature is characterised by an emphasis on quantitative analysis and theory-testing as well as by the use of relatively large speech samples. Frequently-studied topics include verb inflection (e.g. Murasugi, 2015; Sano, 1999; 2002; Shirai, 1993; 1998; Shirai & Miyata, 2006), verb learning in relation to morphological- or syntactic-bootstrapping (e.g. Imai, Haryu, & Okada, 2005; Imai, Lianjing, Haryu, Okada, Hirsh-Pasek, Golinkoff & Shigematsu, 2008; Matsuo, Kita, Shinya, Wood, & Naigles, 2012; Oshima-Takane, Ariyama, Kobayashi, Katerelos, & Poulin-Dubois, 2011), case marking and argument structure (e.g. Morikawa, 1989; Takezawa, 1987), and word-order including scrambling (e.g. Otsu, 1994 Gervain, Nespor, Mazuka, Horie & Mehler, 2008). Studies on Japanese child-directed speech and language socialization have focused especially on topics such as the nature of 'baby talk', and social routines in the child-caregiver interactions (e.g. Clancy, 1986; Cook, 1996; 1997; Fernald, & Morikawa, 1993; Morikawa, Shand, & Kosawa, 1988).

2.1 The General developmental path of child Japanese

The earliest stage of children's speech production is the one-word stage in which children start producing words for familiar objects or actions that include many baby words (e.g. *nenne* 'sleep'), onomatopoeic words (e.g. *wanwan* 'bowwow'), person names, and basic verbal routines (e.g. *hai* 'here it is', *baibai* 'bye') (Ogura, 2007). These words can be of different word classes, including verbs (e.g. *(i)nai* (be-NEG.NONPAST) 'not exist'). Although Japanese grammar (e.g. ellipsis of nominal arguments) has been argued to potentially advantage verbs over nouns (Choi & Gopnik, 1995), no clear verb bias has been observed for children (Imai et al., 2005; Ogura, 2007; Ogura, Dale, Yamashita, Murase & Mahieu, 2006; Okubo, 1980). The majority of utterances in this stage are assumed not to be analysed or productive, or to reflect an adult-like understanding of the meaning and function of linguistic forms (e.g. Clancy, 1985; Shirai, 1998). At formal level, however, Shirai & Miyata (2006) showed early emergence of the first "contrastive" use of inflection, namely the use of both past and other inflectional forms (for different verbs), in the speech of children aged 1;3-1;10 and "contrastive" use for a same verb at 1;5 – 2;0. (Though of course the use of "contrastive" forms does not demonstrate that children themselves understand the contrasting functions of the relevant morphemes).

Reflecting the abundance of postpositional functional morphemes, utterances in this stage (especially the second half of the second year) often consist of a content word followed by a grammatical morpheme (Murata, 1961). One type of these utterances is noun plus a case marker. Genitive marker *-no* tends to appear relatively early, typically with children's own name (e.g. *Ritchan-no* 'Ritchan's'). The topic marker is also used often especially for asking context-dependent general questions such as *Papa-wa?* 'What about/where is dad?' with rising intonation (Clancy, 1985). Utterance-final modal particles such as *yo* (assertive/emphatic), and *ne* (seeking/indicating agreement) are frequently present in the input and emerge in children's language as early as 1;1-2;0, when their MLU is about 1.1-1.2 (Shirai, Shirai & Furuta, 1999). These combinations of lexical item + grammatical morphemes have been argued to be equivalent to the pivot schemas (Braine, 1963; Tomasello, 2003) posited in some studies of English (e.g. Takanashi, 2009).

At around 2 years of age, children start producing two-words utterances and showing more flexible use of morphological and syntactic patterns. Two-words utterances typically consist of different types of word combinations; relatively well-structured utterances such as *kore kowai* (this scary) 'this is scary', and more loosely structured utterances such as *papa yonde* (daddy read.IMPERATIVE) 'Daddy, read (this)!' or *jiichan baachan* 'grandpa (and)

grandma' (Murata, 1961). Verbs tend to be inflected for several different categories, including imperative, past and nonpast forms, although their productivity may be limited in scope (Clancy, 1985). Abstract morpho-syntactic knowledge has also been argued to emerge at around 2 years of age. Oshima-Takane et al. (2011) argue that children aged 1;8 are able to use an intransitive verb sentence structure to guide early verb learning on the basis of an experimental task involving the mapping of novel word to a novel action (Imai et al., 2005; Imai et al., 2008).

Children then start producing longer utterances, showing more proficiency with case marking and verb inflection. They show more productive use of frequent inflections, and become used also to less frequent inflectional categories such as polite and cohortative forms, or morphologically more complex forms such as passive past forms (Iwatate, 1981), at the same time showing considerable individual variation (e.g. Clancy, 1985). Complex sentences such as conditionals (Akatsuka, & Clancy, 1993) and coordination using connectives (e.g. -*kara* 'because') also appear in children's speech around their third birthday (Clancy, 1985). Children become able to handle relatively implicit meanings such as modal and epistemic meanings. For example, an experimental study by Matsui, Yamamoto and McCagg (2006) showed that Japanese 3-year-olds can understand the certainty and the quality (or directness) of evidence as expressed by using sentence-final particles (e.g. *yo*, *kana*). At the same time, the acquisition of Japanese is a relatively protracted process, especially for polite language (Clancy, 1985; Nakamura, 2001a): Some highly formal or reverential registers require a sophisticated socio-cognitive knowledge and their acquisition continues after the school years, into adulthood.

It is worth mentioning at this point that apparently "early" and "error-free" use of grammatical forms such as verb inflections and case markers (as compared with languages such as English; e.g. Clancy, 1985; Tanoue, 1981), may in fact be more a reflection of the nature of Japanese grammar. As Clancy (1985) argues, grammatical features of (especially spoken) Japanese, such as the extensive ellipsis of nominal arguments and case markers, the lack of verb agreement, and relatively free word order, make it difficult for researchers to judge whether children's utterances are well-formed with regard to the intended message especially in early stages. Japanese child language at the one- and two-word stages appears more grammatically complete and correct than English child language because the many type of ellipses that constitutes errors in English are grammatical in Japanese (Clancy, 1985). This language-specific feature should be taken into account especially in naturalistic data studies of children's grammatical ability.

2.2 Acquisition of verb inflection

Many previous studies report that Japanese acquisition is characterised by early mastery of verbal inflections. According to Clancy's (1985) summary, Japanese children typically start using several different inflections by the age of 2 years. These early inflections tend to include imperative, past, present progressive, nonpast, completive past, negative nonpast, and desiderative nonpast (Clancy, 1985: 426). For example, in Rispoli's (1981) data, past inflection appears earlier than any other inflection, followed by the nonpast, completive past and completive nonpast inflections. Tanoue (1981) reports early productive use of inflections, arguing that some inflections become productive even before MLU reaches 1.5; much earlier than for English where few grammatical morphemes appear before MLU 2. Though productivity is defined differently across researchers, many studies agree that Japanese verb inflection is used from relatively very early on, with some productive knowledge. That said, as discussed in the previous section, it is difficult to know whether young children's knowledge is really productive or simply reflects (a) rote learning of different morphological forms of the same verb and/or (b) the difficulty of detecting errors, given the many types of ellipsis are permitted in Japanese.

That said, although observable errors are generally rare in the acquisition of Japanese verbs, a number of different types of errors have been reported in the literature. According to Clancy (1985), one typical error in child Japanese concerns the use of the connective inflection (*–te*/*de*). This error can be considered a type of omission error, in which a complex verb phrase V-*te* V is intended but not produced completely (e.g. **oti-te* < *oti-te kuru* (fall-CONNECTIVE come-NONPAST) 'fall down') (e.g. Rispoli, 1981). Other types of errors include ill-formed negation such as **mi-ru-na-i* (see-NONPAST-NEG-NONPAST) for *mi-na-i* (see-NEG-NONPAST) (e.g. external negation; Sano, 2002), the misuse of past form in non-past contexts (e.g. Kato, Sato & Takeda, 2003; Murasugi, 2015; a phenomenon investigated in the present thesis), and morphological errors of potential, passive and causative verb marking. Some of these errors appear to involve the confusion of the distinction between intransitive and transitive verbs (e.g. **oidas-i-ta* kick.out-PAST < *oidas-are-ta* (kick.out-PASSIVE-PAST) 'was/were kicked out') (e.g. Okubo, 1973). Klafehn (2003), on the other hand, argues that most verb errors are stem error (e.g. **aiku* < *aku* (open-NONPAST), the error seems to be related to *aita* (open-PAST)) that result from the unclear boundary of stems, and that many more errors are observed for regulars than irregulars, with no apparent default error pattern. Overall, however, the number of observable errors is small,

which has led to something of a consensus regarding the precocious acquisition of Japanese verbs.

Assuming, for the moment, that inflection is indeed acquired relatively early in Japanese (and apparent early mastery does not solely reflect difficulty in observing errors), this raises the question of why this is the case. Clancy (1985) summarises four possible reasons. First, Japanese has no 'base' form, and every verb is necessarily inflected for some grammatical categories such as tense (thus "bare stem" errors – which are very common in English and related languages – are not possible). Second, verb inflection is perceptually salient because of the use of suffixes, which are applied on utterance-final verbs. Third, frequent ellipsis (absence of nominal elements) results in utterances that consist only of a verb (meaning that the verb is often salient, and not buried in a longer utterance). Fourth, inflection is morphologically regular. Shirai (1998: 297) suggests that the typological feature that verbs are always inflected for some grammatical features enhances the tendency of early reliance on lexical rote learning, in contrast to languages that allow the 'base form' to appear frequently (e.g. English). The reliance on rote-learning is also supported by corpus data analyses in which a given verb stem is generally found only with one or two inflections (e.g. Rispoli, 1981). However, it is important to bear in mind that even if particular inflectional forms appear in children's speech, their function is not necessarily adult-like. For example, Shirai (1998) and Shirai & Miyata (2006) studied corpus data and argued that the past inflection is used for indicating the perfective in early Japanese, and that the contrastive use of the past tense form precedes the onset of deictic past reference.

In summary, early Japanese verb knowledge seems to consist of a mixture of rote-learned forms that are learned directly from the input, and – perhaps – early productive knowledge that is supported by the language-specific characteristics mentioned above. The relative importance of these two types of learning has been an important but also difficult topic. This is because, as noted above, a number of features of Japanese, such as the extensive ellipsis of nominal arguments, relatively free word order, and the absence of verb agreement do not easily allow researchers to identify errors or to assess productivity. The studies reported in the present thesis attempt to overcome these limitations by using adult speech as a control when assessing productivity (Chapters 4 and 5) and by using elicited production methods to probe productivity with inflections that children produce only relatively rarely in spontaneous speech (Chapters 6 and 7).

2.3 Topics in the acquisition of verb inflection

This section introduces several important topics in the acquisition of Japanese verb inflection by summarising the literature from different theoretical perspectives and by identifying key questions to be addressed.

2.3.1 Order and age of acquisition of verb inflection

Several researchers have attempted to define the order of acquisition of Japanese inflections, as has been done for English acquisition (e.g. Brown, 1973, Cazden, 1968). For example, according to Clancy (1985: 426), Japanese children's earliest inflections typically include imperative, past, nonpast, progressive nonpast, completive past, negative nonpast and desiderative nonpast. Otomo, Miyata, & Shirai (2015; 203), in a corpus-based analysis, estimated the acquisition of productive use of inflections using a type frequency measure (occurrence with 4 different verbs) and suggest the following order: (1) past, nonpast and imperative (-*te*), (2) connective, cohortative and conditional (-*tara*), and (3) which did not reach criterion for all the children, connective + irregular verb form *kudasai* 'please'. They also studied morphemes that appear between the verb stem and tense marking: completive, negative and stative are the first acquired medial morphemes, followed by potential, polite, and desiderative in addition to some subsidiary verbs. Shirai & Miyata (2006), a study of the acquisition of past inflection included three levels of stringency (contrast between past and other inflections with any different verbs, contrast for a specific verb, and contrast for a specific verb within a recording session) for estimating the onset of children's contrastive inflections (again using type frequency measures). Similarly, Iwatate (1981) studied the order of verb acquisition focusing on morphologically simple and complex forms (including sentence-final particles that are attached to verbs). His hypothesis that children acquire new inflectional forms by adding morphemes to already acquired inflectional forms (in contrast to rote-learning of inflectional forms) was consistent with his analysis of one boy's longitudinal speech data. Takanashi (2009) followed this study and found that complex endings emerged later than simple endings in an analysis of two verbs *ik* 'go' and *ku* 'come'. She concluded that children learn complex endings by adding a morpheme to already-learnt simple endings. She suggests a certain fixed order in the acquisition of inflectional verb forms, which depends mainly on the strategy of learning new forms on the basis of acquired forms rather than on the frequency in the input. In sum, type frequency (or first occurrence) measures have been common in studies on the order or age of acquisition of Japanese verb inflection. While

generally describing a particular order, most of these studies also recognise individual variations in the use of verb inflections.

However, none of these studies control for the sampling problem discussed in the previous chapter; and none attempt to distinguish in a principled way between rote learning and productivity. Thus one of the key questions to be investigated in this thesis is whether there is a fixed common order in the acquisition of inflections, using the same kinds of type frequency measures as the studies discussed above (e.g. Choi, 1991). This will be done by looking for an order that is shared across children, and across acquisition criteria based on different numbers of types (methodological problems discussed in Shirai & Miyata, 2006; Gathercole et al., 1999). In addition, the assumption behind the use of type frequency measures that children's knowledge changes rapidly and categorically from non-productive to productive is also worth revisiting in the light of literature suggesting the gradual development of productivity (e.g. Ambridge et al., 2015). In fact, children's earliest verb use can reflect either item-based lexical learning or the acquisition of abstract patterns (or some combination of the two). In order to investigate this possibility, a study in this thesis investigates the role of input frequency and other factors such as morphological complexity while carefully controlling for unwanted confounding effects.

2.3.2 Usage patterns of verb inflection

Children's usage patterns of verb inflections have been studied in several corpus-based descriptive studies. Although researchers seem to agree on the frequent use of basic inflections such as past and nonpast forms, the relative frequency between inflections varies depending on the dataset used for each study. For example, Rispoli's (1981) study using a child's naturalistic speech sample shows a developmental change in the token and type frequency of different inflections, such that past inflection outnumbers nonpast and other inflections in both token and type frequency in the early stages (1;6-1;11), except for the last stage (2;0) in which stative nonpast forms are as frequent. The second most frequent form is completive past inflection, followed by nonpast inflection. Shirai (1998) analysed the use of past, nonpast and stative inflections in the naturalistic speech data from three children (1;0-2;7). The frequency distribution of these inflections shows variation across these children; past inflection is the most frequent for one child while nonpast is the most frequent for another child; there is also variation within each child across different time points. Okubo (1973) concluded that children around 3-6 years of age frequently used nonpast forms, stative nonpast form, and completive past forms in data from interviews with children. Using the

same dataset, Takahashi (1975) reported that children as young as 3 years old appropriately used nonpast and past forms, but for more complex forms, he noted the non-occurrence of conditional forms and incomplete mastery of passive forms. Murasugi (2015), Murasugi & Fuji (2009), Murasugi, Fuji, & Hashimoto (2007) and Murasugi, Nakatani, & Fuji (2010) focused on a single child's overuse of past inflection, in relation to the RI phenomenon (under the nativist assumption that the past-tense form functions as an RI analogue; as discussed in the previous chapter). According to these studies, past inflection is initially used 100% of the time with various meanings at round 1 year of age. They also note the overuse of completive past form using the data from a different child. However this pattern of usage is reported not to be general in later studies that looked at data from more children (Sugiura, Sano, & Shimada 2016).

Another perspective on children's usage patterns explores the particular verbs that children use with each inflection. Generally, children's use of inflections is lexically restricted in early stages (e.g. Clancy, 1985). For example, Rispoli's (1981) descriptive study shows how different verbs are used with a different range of inflections (e.g. *tomar* 'stop' occurred with past and completive past inflections whereas *i* 'exist' occurred with nonpast and negative nonpast inflections). Shirai (1998) looked at the semantic types of verbs that are used with past and other inflections and showed that past inflection was initially used with stative verbs (e.g. *i-ta* (exist-PAST) 'existed') and later combined often with achievement verbs, whereas stative inflection was not used with stative verbs (see also Cziko & Koda, 1987). Nonpast inflection did not show any general preference regarding verb aspect.

In general, the distribution of different inflections in children's speech has been attributed to either distributional patterns of the input (by functional/usage-based/constructivist approaches) or to grammatical defaults (by generativist approaches). Shirai (1998) looked at the inflections in the child-directed speech of one mother and found the frequent use of past inflection with achievement verbs but no preponderance of any verb class for the nonpast inflection, a distributional pattern which basically corresponded with that observed in child speech. On the other hand, Murasugi and her colleagues argued that children speaking [-bare stem] language like Japanese know that verbs in their target languages cannot surface as bare stems and naturally and voluntarily pick up the most unmarked surrogate form in the adult grammar leading to the overuse of past or completive past inflection (again, as an RI analogue).

These different views on children's usage patterns of verb inflection have not been contrasted in a systematic and quantitative way in the literature. This is a missed opportunity,

given that the descriptive studies that have shown a considerable amount of variation across children and across verbs suggest that Japanese offers a good test case for testing these predictions. An important goal of this thesis then is to uncover any general patterns or tendencies in children's acquisition of inflection, and also to observe variation across verbs and across individual children using datasets from different children. On the basis of careful investigation of naturalistic data it will then be possible to design systematic experimental studies for contrasting different theoretical explanations for the pattern found in the dataset. The generativist view specifically argues for a categorical distribution, namely the default status of past inflection in the RI analogue account of Murasugi (2015). This kind of categorical prediction is shared with many generativist accounts developed for other languages (e.g. Grinstead, 2000; Hyams, 1996; Radford, 1990). On the other hand, the usage-based/constructivist prediction is that children's usage pattern of inflections reflects the item-specific distribution of the input language (e.g. Aguado-Orea & Pine, 2015; Räsänen et al., 2014; 2015). One way in which the present thesis will contrast these views is to analyse the frequency distribution of different inflectional forms in children's speech, and to see whether it shows a categorical or input-based pattern.

2.3.3 Errors of verb inflection

As mentioned above, Japanese-speaking children make several different types of errors such as errors involving connective inflection and stem segmentation. Most of these errors have been described using naturalistic speech data, but only rarely used to test general theoretical claims. Yet, tense inflection has been discussed in terms of RI errors (and person-number marking errors) by some researchers.

RI is the type of error that occurs when children use infinitive verb forms in contexts that require other inflections, as detailed in the previous chapter. Pro-drop (null subject) languages including Japanese have generally been considered non-RI languages. The question for Japanese, then, is whether there is a RI-like error phenomenon in child Japanese. Sano (1995; 1999) has studied this question by addressing three possible different non-finite verb forms; the adverbial form (*-i*), the stem form for negative and other inflections (*-a*), and the connective form (*-te*), none of which is inflected for tense, and can be used as a main verb. He studied whether these forms are erroneously used as main verbs in child Japanese and found no such error, concluding that RI errors are not observed in Japanese. Murasugi & Fuji (2009), Murasugi et al., (2007), Murasugi et al. (2010), and Murasugi (2015), on the other hand, have argued that Japanese shows an RI analogue, on the basis of their corpus analysis

of two children's data. They argue that the RI analogue in Japanese is the past form (or the completive past form for one of the two children) because the function of children's past forms is actually nonfinite. This idea is based on their observation that children initially produce past forms with any verb in any context, including contexts that require other inflections. However, this study was later challenged by Sugiura et al. (2016), who showed that this pattern of usage, including non-adult-like use of past forms, was not generally observed. From a different angle, these errors of using one inflection in contexts that require other inflections (e.g. use of past inflection in nonpast contexts) can be related also to the literature on person-number marking errors; though person-number marking errors per se are not possibe in Japanese, which lacks person number agreement on verbs. Theoretically, person-number marking errors have been associated either with categorically defined learning (morphosyntactic defaulting) or with item-based lexical learning (defaulting to a more frequent or phonologically simpler form). Japanese-speaking children's overuse of past forms or any other erroneous use of inflections can potentially be a good test case for these different accounts.

Problems facing these studies based on the notion of an RI analogue include (1) there is no consensus on what inflection is the default inflection in Japanese, (2) the amount of data used for the studies is small, and limited to naturalistic data, and (3) the analysis is more descriptive and intuitive rather than quantitative. In addition these studies suffer from the more general problem that the RI analogue in so-called non-RI languages is not well-defined in the generativist literature (e.g. Hyams, 2005; Salustri & Hyams, 2003). The approach taken in this thesis is not to look for the Japanese equivalent of well-studied but narrow phenomena such as RI errors, but to use Japanese-speaking children's errors and usage patterns to examine general theoretical claims that have been proposed for various acquisition phenomena (including RI and person-number marking errors). Generativist explanation for these errors are based on inflectional categories (Murasugi and colleagues' claim that past inflection in Japanese is initially used as a default form across contexts). On the other hand, the usage-based/constructivist view assumes varied representational strength of verb forms depending on their distribution in the input. Japanese, by virtue of the verb-specific frequency distribution of inflections, offers a good test case for these two views.

2.3.4 Input frequency and other factors in the acquisition of verb inflection

Previous studies have noted the complex nature of the acquisition of verb inflection, and the importance of various factors. One of the most widely recognised factors in

acquisition is input frequency (e.g. Ambridge et al., 2015). For example, Otomo et al. (2015) showed that the order of children's acquisition of inflectional morphemes correlated with the token and type frequency of these morphemes in child-directed speech. Shirai & Miyata (2006) associate the acquisition of past inflection with the high cognitive salience that results from the high frequency of use. On the other hand, Takanashi (2009), for example, concludes that input frequency does not determine the order of acquisition of inflectional forms of individual verbs.

Regarding other factors, phonological regularity, morpho-phonological complexity, and semantic or conceptual complexity are all well-discussed (but rarely studied) factors in the literature. For example, Otomo et al. (2015) argue that morphological complexity, in addition to input frequency, is one determining factor of the order of acquisition of inflections, on the basis of the apparent late emergence of relatively complex inflections (and endings with subsidiary verbs). Sano (2002) studied children's errors with negative inflectional forms, and found that children produced errors with consonant-ending verb stems that require stem alternation (e.g. **nomu-nai* < *noma-nai* (drink-NEGATIVE-NONPAST) 'not drink') but rarely with vowel-ending verb stems that do not require stem alternation. His proposal that includes a maturation process only for consonant-ending verbs assumes the importance of phonological complexity in children's inflection.

Although input frequency is generally considered to be an important factor for explaining both children's inflectional knowledge and learning of other linguistic structures (e.g. Ambridge et al., 2015), this effect has rarely been observed by statistical means in previous studies of Japanese. In addition, input frequency is likely to interact with other factors that also affect learning. One of these factors is morpho-phonological complexity: children are assumed to acquire and produce morpho-phonologically simple forms earlier and more easily than complex forms. However, input frequency and morpho-phonological complexity are confounded, as simple forms tend to be more frequent than complex forms. Thus controlling for complexity is necessary in order to properly evaluate effects of input frequency. In the field of language acquisition generally, the interaction between multiple factors to shape children's linguistic knowledge has not been sufficiently studied in a systematic and quantitative manner (though exceptions are the interaction between phonological neighborhood density and input frequency in Dąbrowska, 2008; and between semantic generality and input frequency in Theakston et al., 2004). In attempting to understand the complex process of acquisition, it is important to understand the confounding relationship of different factors and, where possible, to disentangle them statistically.

As is the case for the studies mentioned above, language-specific characteristics in different languages provide opportunities for looking at different factors. For example, focusing on Polish, Dąbrowska (2008) studied the dative case endings that vary depending on the gender and the phonological properties of the noun to look at phonological neighborhood density. Japanese, on the other hand, is useful for investigating the relationship between input frequency and morphological complexity by virtue of its agglutinative inflectional morphology and also of its by-verb variation in the distribution of different inflectional forms of the same verb.

3. Research in the present dissertation

3.1. Goal of the present dissertation

The goal of the present dissertation is to test different predictions regarding children's knowledge of verb inflection from usage-based/constructivist and generativist approaches by focusing on Japanese. Japanese verb inflection is a good test case because of its relatively complex morphological system of inflection and the distributional patterns in the usage of inflectional forms. Specifically, the variation in the frequency distribution of different inflections across verbs is the key for contrasting explanations for the research questions detailed below.

3.2 Research questions

The present dissertation combines four independent studies (chapter 4 to 7), each of which tests a particular theoretical prediction (or competing predictions) regarding children's acquisition of Japanese verb inflection. This section introduces the research questions and outlines these studies.

3.2.1 Order/age of acquisition of verb inflection

The first study (Chapter 4) looks at the order/age of acquisition of Japanese verb inflection using a naturalistic speech sample. The question of whether there is a common fixed order in terms of inflectional categories is examined using different type frequency measures, a method that has been widely used in the literature on Japanese and other languages. At the same time, the mechanism by which children produce their earliest verb forms is analysed in terms of input frequency and morphology; two factors thought to influence learning. Importantly, unlike previous studies of Japanese, the analyses are designed to control for sampling effects. Studying both the order of acquisition of inflectional

categories and the order of acquisition of inflected forms in these analyses also allows us to draw conclusions regarding the theoretically relevant distinction between item-based lexical learning and the acquisition of productive morphological patterns.

The chapter has been submitted to the *Language Learning* as "The effect of frequency on acquisition is modulated by morpheme identity in eight Japanese adult-child corpora", co-authored by Franklin Chang, and Julian M. Pine.

3.2.2 Children's usage pattern of verb inflection

The second study (Chapter 5) tests two different theoretical predictions regarding children's usage pattern of different inflections again using a naturalistic speech sample. Generativist accounts predicts a categorical pattern in which the past inflection is used as default for all contexts, while usage-based/constructivist accounts predicts a verb-specific pattern that reflects the distribution in the input language. Specifically, this study analyses the relative frequency of past versus other inflections in children's speech using the naturalistic speech data from 4 Japanese children aged 1;5 to 2;10. A correlational analysis is conducted between the by-verb frequency distribution of these inflectional forms in the child and his/her mother's speech. Dyad-specific correlations were partialled out by the averaged frequency distribution of other mothers, in order to control for possible sampling effects and to see the effect of real individual input.

This chapter has been published in the *Journal of Child Language* as "Comparing generativist and constructivist accounts of the use of the past tense form in early child Japanese", co-authored by Julian M. Pine.

3.2.3 Children's errors of verb inflection

Building on the previous corpus-based study of past and nonpast forms, Chapter 6 describes a production experiment conducted to contrast generativist and usage-based/constructivist views, again focusing on the effect of item-specific frequency distribution in the input. The experiment was designed to elicit errors involving the use of past-tense forms in non-past context and vice-versa. This was done by selecting past-biased verbs and nonpast-biased verbs that were selected on the basis of their frequency distribution in a child-directed speech sample. The past and nonpast inflections are the most basic inflections in Japanese verb inflection, and at the same time show considerable variation in

their relative frequency distribution across verbs. Thus constructivist accounts predict that children will show bi-directional error patterns, depending on the verb. 22 children aged 3;2-5;8 (Study 1) and 26 children aged 2;7-4;11 (Study 2) participated in a sentence-completion experiment that was designed to elicit past and nonpast forms for 20 verbs, half of which were past-biased, and another half were nonpast-biased. The result was analysed by building a mixed effect model for children's response.

The chapter has been submitted to *the Journal of Child Language* as "Testing an input-based account of children's errors with inflectional morphology: An elicited production study of Japanese", co-authored by Ben Ambridge, and Julian M. Pine.

3.2.4 Effect of input frequency and morphological complexity

The final Chapter (Chapter 7) reports another experimental study designed to disentangle the effects of input frequency and morpho-phonological complexity that have often been confounded in the literature. Morpho-phonological complexity is one of the important factors in Japanese, a language with complex agglutinative morphology. However this factor is confounded with frequency, because simpler forms tend to be more frequent than complex forms. This study specifically looks at whether the effect of input frequency is an important explanatory factor, even when controlling for morphological complexity (by looking separately at the acquisition of morpho-phonologically simple and complex forms). Two production-priming studies with different simple-complex form pairs were conducted. Study 1 tested 28 children aged 3;3-4;3 on simple past (simple) and stative past (complex) forms. Study 2 tested 30 children aged 3;5-5;3 on simple past (simple) and completive past (complex) forms. In each study, children produced either simple or complex forms after priming with complex forms, for 10 simple-biased verbs and 10 complex-biased verbs, selected on the basis of the frequency distribution in the input (as for the study reported in Chapter 6). A mixed effect model was again used for analysing children's production of simple and complex forms.

This chapter is under revision for the *Cognitive Science* as "Disentangling effects of input frequency and morpho-phonological complexity on children's acquisition of verb inflection: an elicited production study of Japanese", co-authored by Ben Ambridge, and Julian M. Pine.

3.3 Methodology

The current dissertation presents two corpus-based studies and two experimental studies using a primed sentence-completion paradigm. The combination of corpus and experimental studies is intended to achieve a balanced understanding of children's acquisition of verb inflection, since the advantages and disadvantages of each method complement one another (e.g. Ambridge & Rowland, 2013). The advantage of using a naturalistic speech sample is that it allows us to observe children's actual language use and also their caregivers' speech (which is clearly important for testing input-based predictions). This type of data can be a very rich source of information about the linguistic and extra-linguistic contexts in which children learn to produce speech, developmental change and so on. The corpus studies in the present dissertation take advantage of the richness of corpus data by describing specific patterns in the data, analyzing the usage pattern of forms in both children's and their caregivers' speech, even distinguishing the input of individual caregivers and the averaged input.

However, several difficulties are inherent in corpus-based studies, due to the nature of the data. The randomness or noise in an individual speaker's speech and the sparsity of data are among the most obvious downsides. Consequently, sampling is a potentially problematic issue, and must be controlled when analysing frequency-related phenomena. Perhaps most fundamentally, naturalistic speech data do not provide evidence regarding children's knowledge of low frequency forms that they rarely or never attempt: exactly the forms for which errors are predicted under input-based accounts. This is where experimental methods are called for. Experiments can focus on specific factors of interest by controlling for other factors, and allow for more control when testing specific theory-driven hypotheses than do corpus-based analyses. All of the experimental studies in this dissertation employed a combined production-priming sentence-completion task. This experimental method successfully sampled children's production in a prompted – and hence controlled – but relatively spontaneous way. The methods for both experimental studies were adjusted in response to pilot findings and – in the first case – an unpublished study. Finally, each experimental paper/chapter reports two closely related studies that serve as conceptual replications of one-another, contributing to the reliability of the results.

Another methodological advantage of this work is the use of quantitative analyses in all the studies. The four studies include different general linear model analyses including correlation, partial correlation, regression and mixed effect models. The use of statistical

methods is already standard in psycholinguistic research. However there are still many questions in the area of (particularly Japanese) morphological acquisition that previously lacked a systematic quantitative analysis, as opposed to the more descriptive analyses that are common in the literature (particularly for under-studied languages). That said, the current thesis also includes descriptive analysis in two corpus-based studies, which is useful for getting a "feel" for children's actual speech, which is important before proceeding to quantitative corpus-based analyses and experimental studies.

Finally, it is worth emphasising the importance of crosslinguistic examination of general theories of child language acquisition. Japanese verb inflection is quite different from inflection in English or other major European languages not only in a typological sense but also in terms of its probabilistic patterns of by-verb usage. This distinctive property is the key for contrasting different theoretical claims that have not been clearly differentiated in previous studies of other, well-studied languages. It is essential to choose languages that have suitable characteristics for testing specific predictions; and also to check that claims and theories developed for one language (or language family) extend to typologically different languages. I hope that, by contributing to our growing cross-linguistic understanding of inflection, this dissertation will allow us to build better general theories of child language acquisition.

Chapter 4: Exploring the order and age of acquisition of verb inflections in Japanese

Rationale for the study in Chapter 4

The study reported in Chapter 4 explores the order and age of acquisition of verb inflections in early child Japanese by combining descriptive and statistical analyses on naturalistic speech data from CHILDES (MacWhinney, 2000).

Identifying the order of acquisition of grammatical morphemes has been a common practice in the field of language acquisition and is used as a way of understanding developmental changes in children's linguistic knowledge. Many previous studies have estimated the point at which the child has acquired an inflectional morpheme by using type frequency criteria (e.g. Gathercole et al., 1999; Weist, Pawlak & Carapella, 2004), assuming, for example, that the use of the past tense marker with five different verbs signals the productive use of this morpheme. The assumption behind the use of this measure is that children's knowledge of grammatical morphemes may initially be embedded in unanalysed forms, but becomes productive at some early point in development. Although it is recognised that there are both theoretical and methodological problems with this kind of measure (e.g. Gathercole et al. 1999; Shirai & Miyata, 2006), the use of type-based measures is still common in the field, especially when studying highly inflected languages. For example, the type frequency method has been used to investigate order of emergence in Japanese (e.g. Otomo et al., 2015), which is understandable given the difficulty of identifying obligatory contexts in Japanese children's speech because of its relatively flexible word order and the extensive ellipsis of syntactic constituents. The first part of the study in Chapter 4 therefore investigates the order of acquisition of verb inflections in early child Japanese using three different acquisition measures in order to investigate the reliability and validity of the type frequency approach.

Another way of investigating order and age of acquisition is to investigate what factors predict the age at which different verb forms emerge. Although acquisition is assumed to be influenced by many different factors including input frequency, and morpho-phonological regularity and complexity, the literature addressing how these factors interact (e.g. Dąbrowska, 2008, Theakston et al., 2004) has been very limited. The second part of the study aims to explore which factors affect the age at which Japanese-speaking children's verb forms emerge, focusing particularly on input frequency and morphological complexity, both

of which have been assumed to be important in language acquisition in the past (see Ambridge et al., 2015; Ellis, 2002 for reviews of the role of input frequency; see Dressler, 2005 for a review of the role of morphological complexity). How these factors interact is of particular in interest in Japanese as previous studies in this language have reported mixed results (e.g. Otomo et al., 2015; Takanashi, 2009).

The third and final part of the study focuses on disentangling the effects of form frequency and sampling. As pointed out by Tomasello & Stahl (2004), this is a problem with a number of previous studies that have focused on order of acquisition by using type frequency measures or have reported frequency effects without controlling for the likelihood that different forms will be sampled in children's speech. In this study we use regression analyses to control for sampling issues by looking for effects of form frequency in the input while controlling separately for both the frequency of the verb lemma and the frequency of any other morphemes included in the verb form.

The study reported in Chapter 4 introduces a number of key issues in the study of Japanese verb morphology and sets the scene for a number of the questions examined in Chapters 5, 6 and 7.

1. Introduction

How children learn the system of verb inflection in their language is a long-standing question in the field of language acquisition research (e.g. Berko, 1958; Brown, 1973; Cazden, 1968; Dressler, 2010; MacWhinney, 1978; Pinker, 1984; Pizzuto & Caselli, 1992; Shirai & Andersen, 1995; Slobin, 1985; Tomasello, 2000; Wexler, 1994; 1998). Research in this area has focused on a number of questions, including: When does knowledge of different verb inflections become productive? What factors determine the order of acquisition of different inflections? And to what extent is children's knowledge of verb inflection related to the frequency with which particular forms occur in the input? However, providing satisfactory answers to these questions is more difficult than it might at first appear, because it requires the researcher to solve a number of methodological problems relating to the questions of how to establish order of acquisition, how to operationalize predictors such as semantic and morphological complexity, and how to disentangle frequency and sampling effects on age of acquisition.

With these challenges in mind, the aim of the present study is to investigate the acquisition of verb morphology in Japanese, a language with highly agglutinative verb morphology, in which all verb forms are marked with at least one suffix – but many are more complex, and are marked with a number of different suffixes. We focus on naturalistic corpora of early child Japanese and investigate the following questions: 1) Is there a relatively consistent order of acquisition of verb inflections across children - and how dependent is this order on the criterion used to establish order of acquisition? 2) What factors affect the age at which different verb forms emerge in Japanese-speaking children's speech – and, in particular, is there a systematic relation between age of acquisition and morphological complexity? And 3) Is it possible to establish a relation between the age of acquisition of particular verb forms and the frequency with which those forms occur in the input, even after controlling for sampling effects in naturalistic speech?

1.1 Order of emergence

Since Brown's (1973) seminal study of 14 English morphemes, many researchers have sought to investigate the order in which different morphemes become productive in children's speech, and to do so across a range of different languages (see Chapters in Slobin, 1985 for examples). Brown's study did not focus specifically on verb morphology, but it did appear to show a relatively invariant order of acquisition across the 14 morphemes studied

(though this conclusion has been qualified to some extent by subsequent research, e.g. de Villiers, & de Villiers, 1973; James & Khan, 1982).

Central to Brown's approach was the use of the 90% obligatory context criterion, according to which a morpheme was only considered acquired if it appeared in 90% of the contexts in which it was required in 3 consecutive recordings. The great strength of this criterion is that, by focusing on the percentage of obligatory contexts filled, it controls for the number of opportunities that the researcher has to observe the use of a particular morpheme in the child's speech. However, an obvious limitation is that the 90% cut-off means that it is effectively a measure of mastery rather than a measure of productivity. This limitation has led many researchers to develop much less conservative criteria for attributing productive knowledge of verb morphology to the child. For example, some generativist researchers (e.g. Wexler, 1998) argue, on the basis of the low rates of errors of commission in children's speech, that children's use of verb morphology is productive from the earliest observable stages – and hence effectively adopt a first use productivity criterion. On the other hand, other researchers, who are more sensitive to the possibility that children's early use of morphology might be embedded in unanalyzed forms, argue for type-based criteria that attribute productivity on the basis that the child has been observed to use a particular morpheme with some criterial number of different verbs (and in some cases the relevant verbs with some criterial number of different morphemes). For example, in their work on Romance languages, a number of investigators (e.g. Fernández Martínez, 1994; Gathercole et al., 1999; Pizzuto & Caselli, 1994) attribute productive knowledge of verb inflections on the basis that the relevant inflection had been used with at least two different verbs and the relevant verbs with at least two different inflections; in her work on Korean, Choi (1991) attributes productive knowledge of modal suffixes on the basis that the relevant suffix had been produced with more than three different verbs; and in their work on Japanese, Otomo et al., (2015) attribute knowledge of verb inflections on the basis that the child had produced the relevant suffix on at least 4 different verbs.

These kinds of type-based measures have the advantage that they can, in principle, be used from early in development to distinguish between morphemes that are being used productively by the child and morphemes that have been learned as part of unanalysed verb forms. They also have the advantage that they can be used to investigate morphological development in languages like Japanese in which the high rate of argument omission makes it difficult to identify obligatory contexts. However, since they do not control for the number of

opportunities that the researcher has to observe the relevant morpheme, they are likely to be sensitive to sampling effects (Tomasello & Stahl, 2004; Yang, 2013). That is to say, morphemes that occur more frequently in the language are likely to reach criterion earlier than morphemes that occur less frequently in the language, simply because they are more likely to be sampled. This may be a particular problem when attempting to use first use and type-based measures to estimate the order of emergence of morphemes that occur with very different frequencies in the language.

In view of this problem, the aim of the first part of this study is to investigate the order in which Japanese verb morphology becomes productive, but to do so using three different criteria of emergence. This will not only allow us to identify any commonalities in the order of emergence of verb morphology across children, but also to determine how order of emergence is affected by the use of different criteria, and the extent to which different criteria of emergence are sensitive to sampling effects.

1.2 Factors affecting order of acquisition

Research on potential factors affecting the order of acquisition of inflectional morphology in children's speech also has a long history in language acquisition research. For example, both Brown (1973) and de Villiers and de Villiers (1973) considered the extent to which the order of acquisition revealed in their analyses could be explained in terms of input frequency and semantic and grammatical complexity. They both concluded that, while the frequency of morphemes in parental speech did not predict order of acquisition, semantic and grammatical complexity did appear to play a role, though, without a strong means of operationalizing semantic or grammatical complexity a priori, it was difficult to determine the precise role of either of these predictors.

However, an obvious problem with these early studies is that their conclusions relate to the order in which the morphemes in question reached Brown's very stringent acquisition criterion (as opposed to the order in which they became productive). They are also based on a very heterogeneous set of morphemes and a relatively crude measure of input frequency (i.e. the number of tokens of the morpheme in the input as opposed to the number of different nouns or verbs that were marked with the relevant morpheme). All of these factors are likely to militate against finding a relation between input frequency and order of acquisition.

More recent research has tended to distinguish between noun and verb morphology and to reveal frequency effects at a number of different levels. For example, Bybee (1995) discusses the interplay between type and token frequency in determining the productivity of inflection across a number of different systems and languages; Matthews & Theakston (2006) report frequency effects on children's tendency to use both plural –s and past tense –ed correctly; and Räsänen et al. (2014) report effects of the relative frequency with which verbs occur as third person singular versus bare stem forms on the rate at which children produce third person singular forms in obligatory contexts in English (see Ambridge et al., 2015 for a review). While these effects are open to a variety of possible interpretations, they suggest that there may be a stronger relation between input frequency and the acquisition of inflectional morphology, in general, and between input frequency and the acquisition of verb morphology, in particular, than was assumed in Brown and de Villiers and de Villiers' early studies.

With respect to the issue of morphological complexity, cross-linguistic analyses have shed further light on what might be considered morphologically complex from the child's point of view. For example, it has been argued that children find it easier to learn inflections that are morphologically transparent in the sense that they are attached to the stem without altering its phonological form (e.g. Clark, Frant Hecht & Mulford, 1986; Dressler, 2010; Peters & Menn, 1993), and that children find it easier to learn inflections that are morphologically simple in the sense that they exhibit a one-to-one correspondence between meaning and form (e.g. Slobin, 1985; Dressler, 2005; 2010). This kind of morphological simplicity has also been assumed to provide an explanation for why agglutinative systems in which each inflection expresses only one grammatical distinction tend to be learned earlier than fusional systems in which inflections often express several grammatical distinctions at once (e.g. Aksu-Koç & Slobin, 1985; Dressler, 2010). However, it is still unclear how children acquire forms that are complex by virtue of the number of inflectional morphemes that they include. That is to say, it is not clear whether children learn agglutinative verb morphology by learning complex forms as unanalysed wholes and only subsequently identifying the relation between the component inflections and the distinctions that they encode (e.g. Mithun, 1989), or whether children start by learning simple forms to which they add morphemes as they identify the distinctions that these additional morphemes encode in the input (e.g. Iwatate, 1981; Takanashi, 2009).

In view of these questions, the aim of the second part of this study is to investigate the relative importance of input frequency and morphological complexity in determining the age

of acquisition of verb morphology in Japanese. Since it is difficult to establish the age at which particular morphemes become productive in children's speech, we adopt a data-driven approach to this issue and use regression analyses to investigate the extent to which it is possible to predict the age of acquisition of particular verb forms in terms of 1) the frequency with which those same verb forms occur in the input language and 2) the complexity of those verb forms as measured by the number of inflectional morphemes included in the verb form. The assumption is that systematic effects of morphological complexity will imply that the child is building complex forms out of their component parts, whereas strong effects of form frequency will suggest an important role for the learning of unanalysed forms.

1.3 De-confounding frequency and sampling effects on age of acquisition

There is now a considerable amount of evidence that the frequency with which particular words and sequences occur in the input plays an important role in determining the age at which these forms are acquired by the child (e.g. Huttenlocher, Haight, Bryk, Seltzer, & Lyons, 1991; Naigles & Hoff-Ginsberg, 1998: Rowland, Pine, Lieven & Theakston, 2003; Theakston et al., 2004), However, much of this evidence is based on naturalistic samples and is therefore subject to the potential criticism that age of acquisition is confounded with sampling effects.

This is because, as Tomasello and Stahl (2004) point out, although the frequency with which forms occur in the language is likely to affect the rate at which they are learned, it is also likely to affect the probability that they will be observed in any given speech sample, with the result that high frequency forms are likely to be observed earlier than low frequency forms even if they were actually acquired at the same point in time (see Yang, 2013 for a related argument).

In view of this problem, a third and final aim of the present study is to investigate the extent to which it is possible to establish a relation between the age of acquisition of particular verb forms in Japanese and the frequency with which those forms occur in the input, even after controlling for sampling effects in naturalistic speech. This will be done by using regression techniques to look for an effect of form frequency on age of acquisition while controlling for the likelihood that a particular form will occur in the language as indexed by the combined frequency of the verb stem, and each of the inflections included in the form.

To summarise, the aim of the present study is to investigate the acquisition of verb morphology in Japanese, with a view to answering the following questions: 1) Is there a relatively consistent order of acquisition of verb inflections across children? 2) What factors affect the age at which different verb forms emerge in Japanese-speaking children's speech? And 3) Is it possible to establish a relation between the age of acquisition of particular verb forms and the frequency with which those forms occur in the input, even after controlling for sampling effects in naturalistic speech? In the final section of the introduction we provide a brief sketch of inflectional verb morphology in Japanese together with a brief review of previous work on Japanese that has attempted to address these questions.

1.4 Inflectional verb morphology in Japanese

Japanese has a relatively rich system of verb inflection in which a number of distinctions, including tense, aspect, voice, polarity and politeness are expressed by means of suffixation on verb stems. In contrast to languages with fusional verb morphology like English, Japanese verb morphology is highly agglutinative. Thus, according to Shibatani (1990: 221) Japanese inflectional endings "are fairly clearly segmentable, and the segmented endings (or suffixes) are correlated with inflectional categories in a one-to-one fashion". The simplest finite verb form consists of a verb stem with a tense-marking suffix (non-past or past), as in *tabe-ru* eat-NONPAST 'eat' and *tabe-ta* eat-PAST 'ate'. However, because Japanese verb morphology is highly agglutinative, more complex verb forms are also relatively frequent. These consist of a verb stem with further suffixes attached between the stem and the final tense-marking suffix (e.g. *tabe-ta* eat-PAST 'ate', *tabe-sase-ta* eat-CAUSATIVE-PAST 'forced to eat', *tabe-sase-rare-ta* eat-CAUSATIVE-PASSIVE-PAST 'be forced to eat').

Previous work on the acquisition of verb inflection in Japanese has identified a number of morphemes that appear early in children's speech. For example, Clancy (1985) lists all of the following as early-acquired morphemes or morpheme combinations: *-te* imperative, *-ta* past, *-teru* progressive/resultative nonpast, *-ru* nonpast, *-chatta* completive past, *-nai* negative nonpast, *-tai* desiderative nonpast (labels are modified by the current authors for consistency). It is difficult to determine how productive children's knowledge of these morphemes is. However, children's early use of these morphemes appears to be largely error-free (Clancy, 1985; Kato et al., 2003), and Tanoue (1981) claims that at least some of them are used productively before the child reaches an MLU of 1.5, which is considerably

earlier than in English, where verb morphology is rare before the child reaches an MLU of 2.0.

As regards, order of acquisition, in a recent corpus-based study of 4 children, Otomo et al. (2015) argue that the order in which Japanese verb inflections become productive is relatively consistent across children. This study used a type-frequency criterion according to which the point at which the child had been observed to produce the target inflection with 4 different verbs was regarded as the point of onset of productive knowledge. Otomo et al. argue on the basis of high correlations between order of acquisition and type and token frequency in child-directed speech that this consistent order of acquisition is determined by the frequency with which different morphemes occur in the input. However, they also discuss semantic and morphological complexity as potentially important factors.

On the other hand, studies that have focused specifically on the way in which complex forms are acquired, have tended to downplay the role of input frequency. For example, in another corpus-based study, Iwatate (1981) interprets the data on order as providing support for the idea that complex inflectional forms are learned by attaching morphemes to already acquired simple forms, and in a study of children's use of the high frequency verbs 'go' and 'come', Takanashi (2009) argues that there is a common order in the acquisition of verb inflections, and that this order is not determined by input frequency, but by the tendency for children to learn simple forms early and more complex forms later.

To summarise, although the previous literature suggests that Japanese-speaking children have at least some productive knowledge of verb inflection relatively early, it is much less clear whether the order in which particular inflections are acquired is consistent across children, or how order of acquisition is affected by input frequency and morphological complexity. The aim of the present study is therefore to clarify these issues with a view to increasing our understanding of the way in which agglutinative morphology, in general, and Japanese morphology, in particular, are acquired.

2. Method

2.1 Corpora

The corpora used in the present study were those of 8 Japanese-speaking children and their caregivers: three children (Aki, Ryo and Tai) from the Miyata corpus (Miyata, 2004a; 2004b; 2004c), 4 children (ArikaM, Asato, Nanami, Tomito) from the MiiPro corpus (Miyata

& Nisisawa, 2009; 2010; Nisisawa & Miyata, 2009; 2010) and one child (Noji) from the Noji corpus (Noji, Naka, & Miyata, 2004; Noji, 1973-77). All of these corpora are available in the CHILDES database (MacWhinney, 2000).

Both the Miyata corpus and the MiiPro corpus consist of transcriptions of naturalistic interactions between children and their caregivers and other family members recorded at weekly, monthly or bi-monthly intervals. The Noji corpus is a diary-based corpus derived from hand-written records made by the caregiver on a day-to-day basis. Although this corpus does include records of the speech addressed to the child, these data were not used in the present study because they are not morphologically coded. All the error instances were eliminated by using the error code in these corpora for the analysis on the order of acquisition in the first part of the study. However, in the second and third part of the study which employed a probabilistic approach to the combined large dataset, all the utterances were sent to the analysis.

Details of each of the corpora used in the study are provided in Table 7, from which it can be seen that these corpora vary considerably both in terms of the age ranges covered and in terms of the number of relevant child and adult utterances.

Table 7. Details of 8 Japanese corpora used in the study

Name of corpus	Number of adult utterances that included a verb	Number of child utterances that included a verb	Age range over which recordings were made
Aki	9530	4380	1;5-3;0
ArikaM	15738	19214	3;0-5;1
Asato	6495	3026	3;0-5;0
Nanami	18137	7057	1;1-5;0
Noji	0	15651	1;5-3;11
Ryo	6280	6883	1;4-3;0
Tai	14127	9377	1;5-3;1

Tomito	9928	3734	2;11-5;1
Total	80235	69322	

2.2 Analyses

The corpus data described above were subjected to three different kinds of analysis. The first of these focused on the order of emergence of particular endings (i.e. particular suffixes (e.g. Past, Nonpast) or sequences of suffixes (e.g. Completive-Past, Stative-Nonpast); the second focused on the age of acquisition of particular verb forms (e.g. eat-Past, drink-Completive-Nonpast) and factors that might potentially predict age of acquisition (e.g. form frequency in the input and morphological complexity); and the third focused on the relation between the age of acquisition of particular verb forms and their form frequency in the input after controlling for the potentially confounding effects of sampling.

3. Results

3.1 Is there a fixed order of emergence?

The first analysis focused on the order of emergence of the first 10 endings (i.e. different suffix or suffix combinations) in the corpora of three of the children (Nanami, Ryo and Tai). The corpora of these children were chosen for analysis on the basis that they were the only three corpora that included data from the very beginning of the children's early verb use. We are interested in whether the earliest morphemes are simple/complex and/or sensitive to frequency. We are also interested in whether there is consistency across children in the morphemes that are first learned. Utterances that included verbs were extracted from the corpora and used to establish the first 10 endings to emerge according to three different criteria. These were first use; use with 5 different verb types; and use with 10 different verb types. The order of emergence data for each child were then used to investigate the extent to which there was a relatively consistent order of emergence across the three children and the extent to which this was dependent on the criterion of emergence used. In the first section of the results, we investigate the order of emergence of the first 10 inflectional endings in the three children for whom data are available from early in development. In order to assess the effects of measuring emergence in different ways, the data were analysed using three different criteria: first use, use with 5 different verb types, and use with 10 different verb types. The results of this analysis are presented in Table 8.

Table 8. The order of emergence of the first 10 inflectional endings for three children using three different criteria (First use, Type frequency of 5, Type frequency of 10) together with the age at which each child reached criterion

Nanami		Tai	Ryo
First Use			
1	Nonpast (1;3)	Past (1;3)	Past (1;11)
2	Imperative:*te* (1;3)	Completive-Past (1;3)	Completive-Past (1;11)
3	Past (1;4)	Nonpast (1;3)	Imperative:*te* (1;11)
4	Negative-Nonpast (1;8)	Stative-Nonpast (1;3)	Negative-Nonpast (1;11)
5	Connective (1;10)	Negative-Nonpast (1;3)	Potential-Past (1;11)
6	Stative-Nonpast (1;10)	Stative-Imperative:*te* (1;6)	Nonpast (2;0)
7	Stative-Past (1;10)	Potential-Nonpast (1;6)	Potential-Negative-Nonpast (2;0)
8	Cohortative (1;10)	Imperative:*te* (1;6)	Connective (2;0)
9	Completive-Past (1;10)	Connective (1;6)	Stative-Negative-Nonpast (2;0)
10	Completive-Nonpast (1;10)	Stative-Past (1;6)	Stative-Imperative:*te* (2;1)
5 Types			
1	Past (1;7)	Past (1;5)	Imperative:*te* (2;0)
2	Nonpast (1;8)	Completive-Past (1;5)	Completive-Past (2;0)
3	Imperative:*te* (1;10)	Nonpast (1;6)	Past (2;0)
4	Connective (1;10)	Imperative:*te* (1;7)	Negative-Nonpast (2;0)

5	Stative-Nonpast (1;11)	Negative-Nonpast (1;7)	Connective (2;1)
6	Negative-Nonpast (1;11)	Connective (1;8)	Nonpast (2;1)
7	Cohortative (2;2)	Desiderative-Nonpast (1;9)	Stative-Negative-Nonpast (2;2)
8	Completive-Past (2;3)	Stative-Nonpast (1;9)	Stative-Nonpast (2;2)
9	Stative-Negative-Nonpast (2;3)	Potential-Negative-Nonpast (1;9)	Potential-Negative-Nonpast (2;4)
10	Stative-Past (2;3)	Stative-Past (1;9)	Stative-Past (2;5)

10 types			
1	Past (1;10)	Past (1;6)	Past
2	Nonpast (1;10)	Nonpast (1;6)	Nonpast (2;1)
3	Imperative:*te* (1;11)	Completive-Past (1;7)	Negative-Nonpast (2;1)
4	Connective (2;2)	Imperative:*te* (1;9)	Connective (2;1)
5	Stative-Nonpast (2;2)	Negative-Nonpast (1;9)	Completive-Past (2;1)
6	Cohortative (2;4)	Connective (1;10)	Imperative:*te* (2;2)
7	Negative-Nonpast (2;4)	Stative-Nonpast (1;10)	Stat-Neg-Nonpast (2;4)
8	Stative-Past (2;4)	Desiderative-Nonpast	Stative-Nonpast (2;5)
9	Stat-Neg-Nonpast (2;4)	Stative-Past (2;0)	Stative-Past (2;6)
10	Completive-Past (2;6)	Completive-Nonpast (2;1)	Potential-Negative-Nonpast (2;10)

It is clear from Table 8 that there is substantial overlap in the identity of the children's first 10 inflectional endings, with 6 endings: Past, Nonpast, Imperative, Completive Past, Connective and Negative Nonpast among the first 10 to emerge for all three children, irrespective of criterion, and two further endings: Stative Past and Stative Nonpast among the

first 10 to emerge when the more conservative type-based criteria are applied. On the other hand, there are also some differences between the children. For example, the Desiderative Nonpast, which, according to Clancy (1985), is acquired early, is among the first 10 endings to emerge for Tai, but not for either of the other two children, whereas the Cohortative (which can be used to express similar functions to the Desiderative) is among the first 10 forms to emerge for Nanami, but not for either of the other two children, again irrespective of criterion.

Perhaps the most striking feature of the data in Table 8, however, is the number of complex or multi-morphemic endings that emerge early in all three children, with the Completive Past, Negative Nonpast, Stative Past and Stative Nonpast reaching the more conservative type-based criteria early in all three cases, and complex endings making up at least half of the first 10 endings for all three children, irrespective of criterion. This would seem to count against the widespread assumption that complex forms emerge later than simple forms (e.g. Bassano, 2000; Clark et al., 1986; Otomo et al., 2015), or the idea that complex forms are constructed by adding morphemes to simple forms that have already been acquired (e.g. Iwatate, 1981; Takanashi, 2009).

In order to investigate the effects of using different criteria to estimate order of emergence, Spearman's rank order correlations were computed between the order in which the first 10 endings emerged for each pair of children. Note that where endings were among the first 10 to emerge for one child but not another, these endings were assigned a ranking greater than 10 and adjusted for ties for the child for whom they did not reach criterion, and included in the analysis (which is why the degrees of freedom vary across child pairs). These correlations are presented in Table 9, from which it can be seen that, although the correlations for the first use criteria were low and non-significant (.340-.344), the correlations for the more conservative type-based criteria were relatively high and generally statistically significant (.555-.745, for the 5 types criterion and .591-.811 for the 10 types criterion).

Table 9. Spearman's rank order correlations between order of emergence across children as a function of three different criteria: 1st use; type frequency of 5; type frequency of 10 (degrees of freedom in brackets)

	Nanami-Tai	Nanami-Ryo	Tai-Ryo
First use	.340 (10)	.344 (12)	.344 (12)
5 types	.632 * (10)	.555 (9)	.745 ** (9)
10 types	.600 * (10)	.591 (9)	.811 ** (10)

One interpretation of this pattern of results is that the order in which endings become productive is relatively stable across children, with the inconsistent ordering for the first use criterion reflecting the fact that this criterion is sensitive to the learning of individual forms as unanalyzed wholes. However, it is also possible that the apparently greater consistency with respect to the type-based measures reflects the sensitivity of these measures to sampling effects, with high frequency endings reaching criterion earlier because they are more likely to be sampled than low frequency endings.

In order to investigate this possibility, Spearman's rank order correlations were computed between the order in which the first 10 endings emerged for each child and the frequency with which those endings occurred in the children's speech. These correlations are presented in Table 10, from which it can be seen that order of emergence tends to be strongly negatively correlated with token frequency in child speech and that the size of these correlations tends to increase, the more conservative the criterion of emergence.

Table 10. Spearman's correlations between order of emergence and token frequency of ending in child speech (degrees of freedom in brackets)

First use			5 types			10 types		
Nanami	Tai	Ryo	Nanami	Tai	Ryo	Nanami	Tai	Ryo
-.842** (8)	-.452 (8)	-.457 (8)	-.922** (8)	-.740* (8)	-.498 (8)	-.866** (8)	-.843** (8)	-.809** (8)

These results suggest that the type-based measures of emergence are highly sensitive to sampling effects, and hence that the apparently greater consistency in order of emergence for the type-based measures should be interpreted with some caution. They also raise doubts about the validity of type-based measures of emergence in general, and suggest that such measures may exaggerate the extent to which order of emergence is consistent across children.

This suggestion was investigated further by computing partial correlations between orders of emergence in each pair of children while controlling for the effect of ending frequency in child speech. These partial correlations are presented in Table 11 and provide very little support for the idea that there is a consistent order of emergence across children once one has controlled for sampling effects.

Table 11. Spearman's partial correlation between orders of emergence across children controlling for ending frequency in children's speech

	Nanami-Tai	Nanami-Ryo	Tai-Ryo
First use	-.395 (12)	-.243 (14)	.248 (14)
5 types	-.284 (12)	.187 (11)	.472 (11)
10 types	-.447 (12)	-.238 (11)	.370 (12)

The implication is that, while there is quite a high degree of consistency in the identity of the endings that emerge early in Japanese children's speech, there is also quite a lot of variability in the order in which these forms emerge in the speech of individual children.

3.2 What factors affect the age of emergence of particular inflected verb forms?

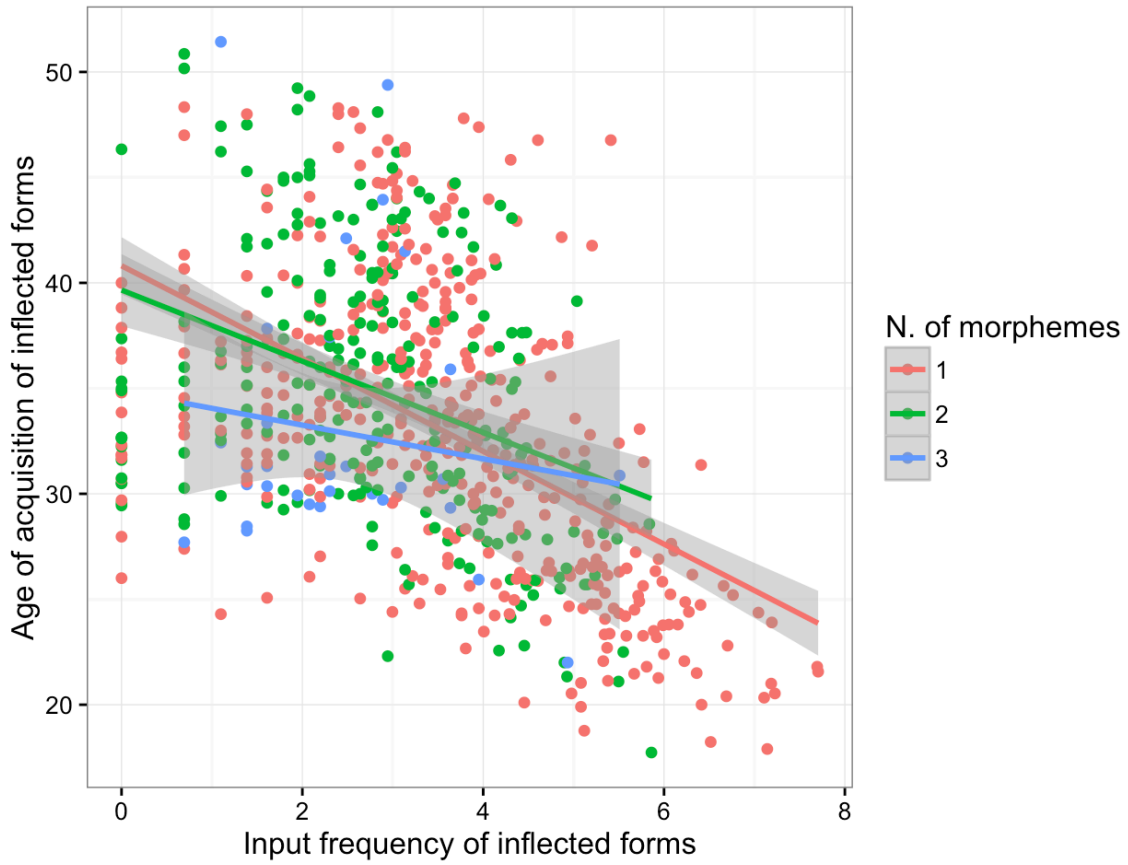
Given the methodological challenges involved in measuring the order of emergence of particular inflectional endings, in the second section of the results, we take a different approach to investigating the emergence of Japanese verb morphology. This involves focusing on the average age at which particular inflected verb forms appear in the data and investigating the extent to which this can be explained in terms of input frequency (i.e. the frequency with which that particular inflected form appears in the input) and in terms of a range of other factors, including morphological complexity and the frequency and identity of medial morphemes in multi-morphemic forms.

Since we want to characterise the role of frequency in Japanese acquisition, we combined all of the data from all 8 available corpora into one *combined dataset*. To reduce sampling effects, a subset of verb forms was extracted from the data on the basis that a) the lemma occurred at least 100 times and b) the form itself occurred at least 5 times in the combined dataset. This resulted in a dataset of 710 different verb forms with 90 different lemmas. The age of acquisition of each of these verb forms was then calculated as the

average age in month at which the first 30 instances of this verb form in the combined dataset and since this number of instances is large, it helps to reduce the chance that these age measure will be influenced by the preferences of a child in a particular recording session. This measure of age of acquisition was then used as the dependent variable in a series of regression analyses in which form frequency in the input, morphological complexity and the identity and frequency of different morphemes and morpheme combinations served as the predictor variables. All of the input frequency measures were based on the child-directed speech from the combined corpus, and were log-transformed and centred before being entered into the models to reduce the skew due to Zipfian effects. All of the categorical variables were dummy-coded. All of the regression analyses were conducted in R (R Core Team, 2015), and the significance of each main effect and interaction was tested by model comparison using R's anova function.

In the first analysis, we constructed a regression model of age of acquisition with logged input frequency of the inflected verb form and morphological complexity (i.e. the number of morphemes in the inflectional ending). This model explained 22% of the variance and revealed a significant negative main effect of input frequency such that children tended to acquire forms with high input frequency early (β=-1.959, t(701)=-12.919, SE=0.152, p<.001). There was also a significant positive interaction between input frequency and complexity, where the negative effect of input frequency grew weaker as complexity increased (β=0.671, t(701)=2.395, SE=0.280, p<.02). However, there was no main effect of complexity (p>.9). These results are plotted in Figure 2, which shows that children's learning of verb forms with one-morpheme endings is particularly sensitive to input frequency, while the effect is less clear for forms with two-morpheme and three-morpheme endings, though it should also be noted that there are only a relatively small number of data-points for the three-morpheme endings.

Figure 2. Age of acquisition of inflected verb forms by logged input frequency of inflected form and complexity (number of morphemes in the inflectional ending)



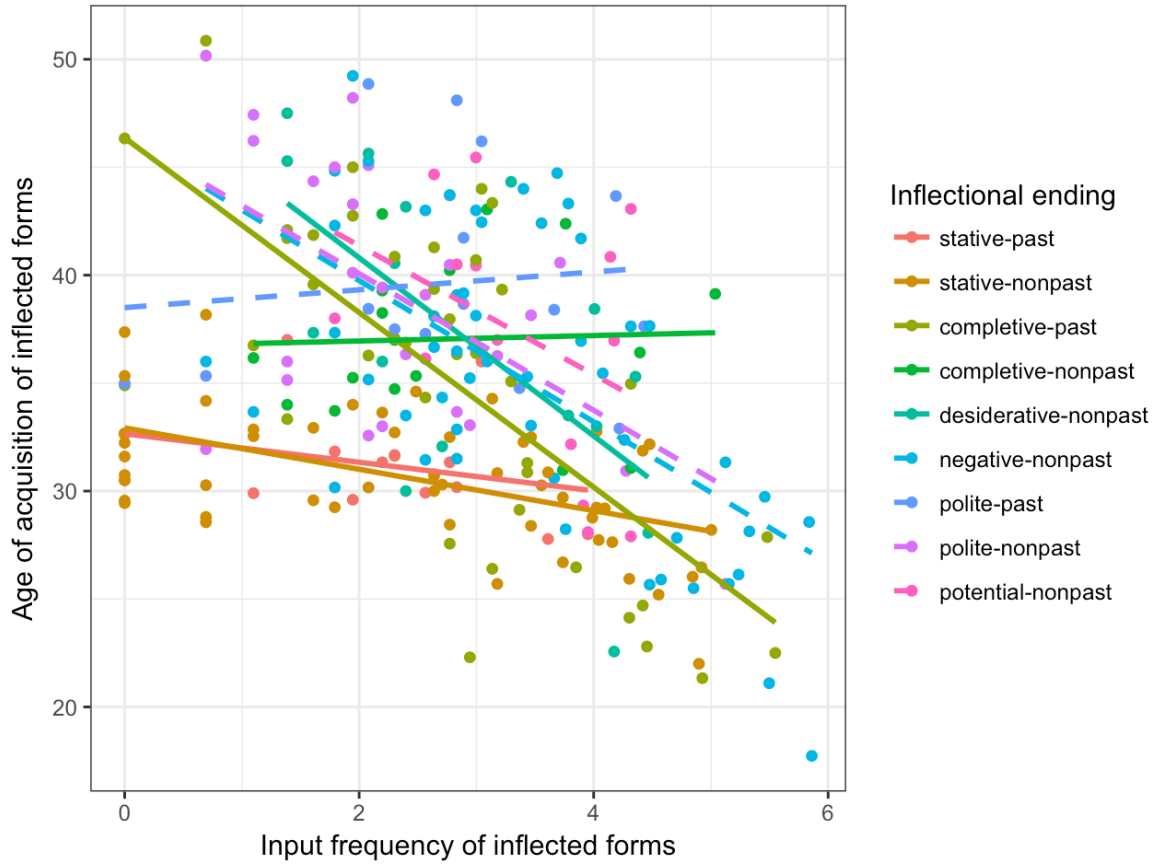
These results suggest that morphologically complex forms are not straightforwardly associated with late acquisition, which is in line with the findings in the previous section. However, it is also clear from Figure 2, that there is a great deal of variability that is left unexplained by frequency of inflected forms.

In a second analysis, we therefore focused exclusively on forms with two-morpheme endings and investigated the extent to which it was possible to explain variability in the age of acquisition of these forms in terms of the identity of the inflectional combinations themselves (Figure 3). A regression analysis of age of acquisition with logged input frequency and ending combination crossed revealed a significant negative main effect of input frequency (β=-0.660, t(233)=-0.516, SE=1.2787, p<.001), where high input frequency was associated with early acquisition. There was also a significant main effect of ending combination (F(242,250)=8.556, p<.001), showing that age of acquisition varied for different endings. For example, stative past forms were acquired earlier than polite past forms (mean

age of acquisition is 31.158 and 39.632 respectively, t(22.076) = 5.701, p<.001). There was also a significant interaction between input frequency and ending combination (F(233,241)=25.292, p<.001), with verbs with certain ending combinations showing greater sensitivity to input frequency than others. For example, completive past forms (e.g. *koware-chat-ta* (break-COMPLETIVE-PAST) 'ended up breaking') show a stronger negative relationship between input frequency and age of acquisition than stative nonpast forms (e.g. *mat-te-ta* (wait-STATIVE-PAST) 'was/were waiting'), resulting in a significant interaction between input frequency and completive past category (the difference in slope between the line for completive past and the line for stative past which is the baseline ending combination, β=-3.385, t(233)=-2.414, SE=1.402, p<.05). These results suggest that there is something about the identity of the two-morpheme endings that is important in determining both the age of acquisition of particular forms and the extent to which age of acquisition is sensitive to the frequency of those same forms in the input. Since this model explained 49% of the total variance, it suggests that ending and frequency are the two main factors that control the acquisition of these forms.

One possible explanation of these effects is that they reflect children's differential sensitivity to the identity of different medial morphemes (e.g. stative *te-* in *tabe-te-ta* [eat-STATIVE-PAST] 'was/were eating' and completive *chaw-* in *tabe-chaw-u* [eat-COMPLETIVE-PAST] 'ended up eating'). Medial morphemes in Japanese mark aspectual, modal or pragmatic distinctions that are essential for defining the type of event or speech act. It is therefore possible that the frequency and identity of these different medial morphemes condition the way that children acquire verb forms in a different way to the frequency and identity of final tense morphemes.

Figure 3. Plot of age of acquisition of inflected verb forms by logged input token frequency of inflected forms and two-morpheme inflectional endings

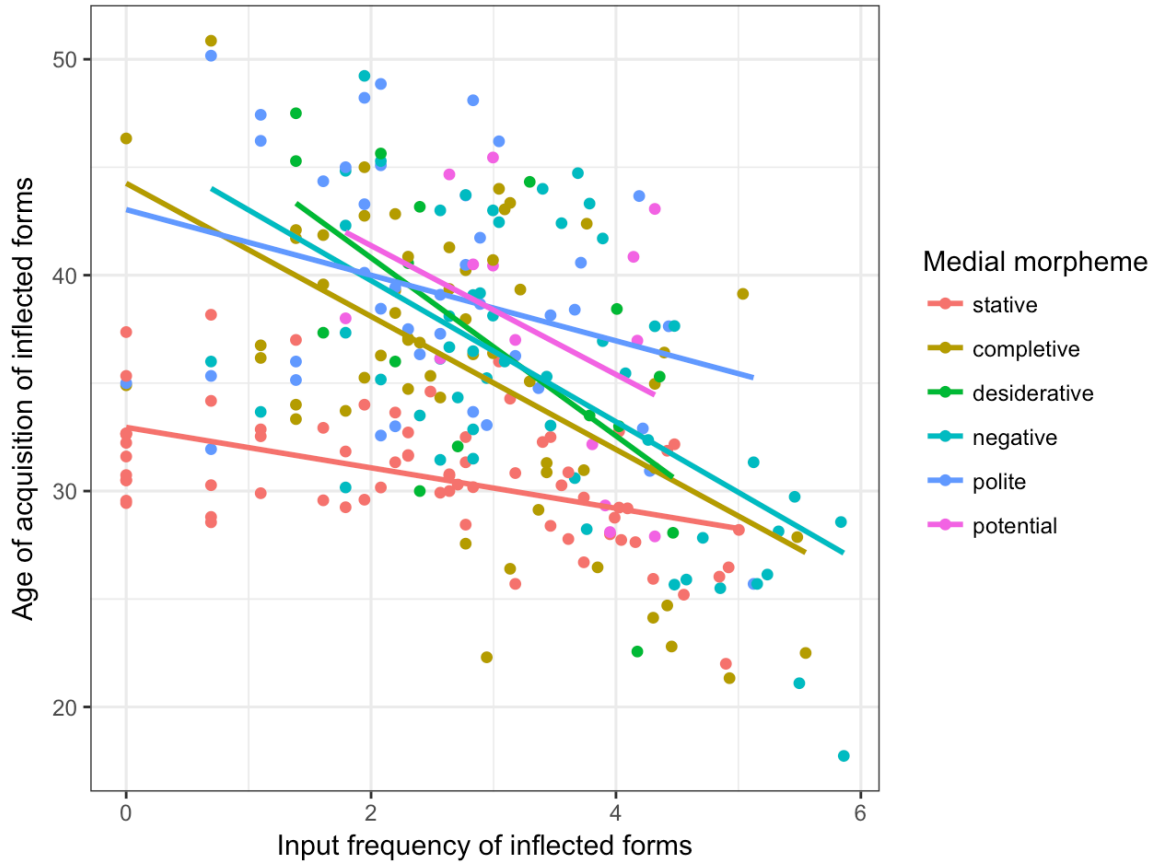


In order to investigate this possibility, two regression models of age of acquisition were constructed which varied in terms of whether logged form frequency was crossed with the frequency or identity of the medial morpheme. The frequency medial morpheme model revealed a significant main effect of form frequency in the predicted direction (β=-4.268, SE=0.558, t(247)=-7.645 ,p<.001), and a significant interaction between form frequency and medial morpheme frequency (β =-1.167, SE=0.251, t(247)=-4.651, p<.001). However, medial morpheme frequency was not a significant predictor (p>.9). Finally, this model explained only 22% of the variance in age of acquisition. In contrast, the identity medial morpheme model (Figure 4) revealed a significant main effect of input frequency in the predicted direction (β=-0.937, t(239)=2.497, SE=0.375, *p*<.001, a significant main effect of medial morpheme identity (F(245,250)=13.48, *p*<.001), with, for example, stative forms being acquired earlier than polite forms, and a significant interaction between form frequency and the identity of medial morpheme (F(239,244)=4.384, p<.001), with stative and polite forms

showing less sensitivity to input frequency than completive, desiderative, negative and potential forms. This identity model explained 45% of the variance, which is a significantly greater percentage than the frequency model ($p<.001$ by anova comparison), which suggests that acquisition is not some additive combination of stem and morpheme frequency, but rather the effect of frequency is modulated by the morpheme that it appears with. The most straightforward interpretation of these findings is that children are more sensitive to the pragmatic distinctions encoded by some medial morphemes (e.g. stative) than others (e.g. politeness), and that some medial morphemes (e.g. stative) are more productive than others (e.g. completive and desiderative) during the early stages, and hence that the age of acquisition of forms that include these morphemes is less sensitive to input frequency.

To summarise, the regression models reported in this section suggest that while there is no straightforward relation between morphological complexity and the age of acquisition of particular forms, the identity of the medial morpheme in complex forms plays a key role in determining both age of acquisition and in mediating the effects of input frequency. These effects suggest that from early on, children are not just encoding the frequency of whole unanalysed forms, but instead are linking pragmatic functions to the components of complex morphemes when encoding their frequency. For example, the frequency of polite morphemes might be counted only with regard to relevant formal contexts, and this context-specific frequency could be the key to understanding the by-morpheme differences in learning. More generally, this idea of the frequency of a linguistic item in relevant contexts (especially the relevant contexts from children's point of view) seems to be in line with the literature that claims the interaction between the effect of functional or semantic properties and the effect of input frequency to explain the varying effect of input frequency in the lexical acquisition of different word types and categories (e.g. Goodman, Dale & Li, 2008).

Figure 4. Plot of age of acquisition of inflected verb forms by logged input token frequency of inflected forms and the medial morphemes in two-morpheme inflectional endings



3.3 Distinguishing between effects of input frequency and sampling effects

All of the regression analyses reported in the previous section reveal effects of form frequency in the input on age of acquisition. However, as noted in the introduction, these effects are difficult to interpret because estimates of age of acquisition based on naturalistic speech samples are confounded with frequency-based differences in the probability that particular forms will be sampled in children's speech. In this section, we therefore attempt to distinguish between effects of input frequency and sampling effects, by looking for an effect of input frequency over and above the likelihood of sampling particular verbs forms as indexed by the combined frequency of the verb lemma (e.g. *tabe* 'eat', *nom* 'drink') the frequency of the medial morpheme (e.g. stative, desiderative), and the frequency of the final morpheme (e.g. past, nonpast) in the input. Using the combined dataset, we built a model of age of acquisition that included the token frequency of the verb lemma, the token frequency of the medial morpheme and the token frequency of the final morpheme as control variables.

We then residualised form frequency against these three frequency variables in order to create a measure of form frequency which is more independent of the sampling frequency.

The resulting model revealed a significant effect for all four predictors. That is to say, the children tended to learn forms with frequent lemmas early (β=-1.597, t(700)=-7.925, SE=0.202, p<.001), tended to learn forms with frequent medial morphemes early (β=-0.905, t(700)=-6.663, SE=0.136, p<.001), and tended to learn forms with frequent final morphemes early (β=-1.101, t(700)=-5.617, SE=0.196, p<.05). However, residualised form frequency was also a significant predictor of age of acquisition (β= -2.229, t(700)=-10.720, SE=0.208, p<.001), with high frequency inflected forms being acquired earlier than low frequency inflected forms. This model explained 23% of the variance.

These results suggest that there is an effect of form frequency in the input on age of acquisition even after controlling for sampling effects, and hence that, although Japanese children appear to be using a number of different verb endings quite productively from relatively early in development, there is still an important role for lexical learning in their early morphological development.

4. Discussion

The aim of the present study was to investigate the order and age of acquisition of Japanese verb morphology through a series of descriptive, correlational and regression analyses. The first part of the study examined the order of emergence of inflectional endings in the three earliest corpora and showed that, although the identity of the earliest endings to emerge was relatively consistent, there was no invariant order of emergence across children. It also showed that, although the order of emergence revealed by more conservative type-based measures was more consistent across children, it was also strongly negatively related to the token frequency of the relevant ending in the children's speech, and hence that this greater consistency was probably at least partly due to sampling effects.

The second part of the study used regression analyses to investigate age of acquisition of inflected forms in a dataset combined across children and showed that the children tended to learn high-frequency forms earlier than low-frequency forms, but that complexity as indexed by the number of inflectional morphemes in the form was not an important factor. This pattern of results counts against the general assumption in the field that simple forms are acquired earlier than complex forms (e.g. Clark et al., 1986; Otomo et al., 2005) and suggests

that complex forms can be learned early provided they occur with sufficient frequency in the input. However, further analysis revealed that there was an interaction between input frequency and the identity of the medial morpheme in complex forms with some complex forms (e.g. Completives) showing strong frequency effects and others (e.g. Statives) showing no frequency effects at all. These findings suggest a complex pattern of acquisition in which the use of some morphemes is highly productive from the child's point of view quite early in development (and is hence insensitive to input frequency) while the use of others is more pragmatically restricted (and hence shows stronger input frequency effects).

The third part of the study used regression analysis to investigate whether it was possible to establish a relation between the age of acquisition of particular verb forms and the frequency with which those forms occur in the input, even after controlling for sampling effects in naturalistic speech. It revealed an effect of form frequency in the input on age of acquisition even after controlling for lemma frequency, medial morpheme frequency and final morpheme frequency. This finding suggests that the input frequency effects revealed in the second part of the study cannot be explained away as sampling effects.

These last two analyses combined all of the Japanese corpora in CHILDES into a single large corpus that provided a much bigger sample than previous studies. Furthermore, we analysed a large set of forms and used age measurements based on the first 30 instances, which helps to make the results in this study less dependent on the particular conversations that happened to occur within particular recording sessions, and instead increased the representativeness of the results. Since we do not have rich enough input to fully characterise the input frequency or usage of particular children, it makes sense to use these aggregated corpora and measures to characterise the typical patterns in the acquisition of the language.

These findings have a number of implications for the field. First, they raise doubts about the validity of type-based measures of productivity. Type-based measures have often been used to establish productivity, particularly by constructivist researchers, on the basis that they show that children's use of a particular morpheme is not restricted to the production of just one or a handful of unanalysed forms. However, the results of the present study suggest that type-based measures are sensitive to sampling effects, with morphemes that occur with high frequency in the language tending to reach criteria earlier than morphemes that are relatively infrequent. This finding is not particularly surprising. However, it does suggest that such measures may be of limited usefulness, since it means that the results that they generate are at best difficult to interpret. For example, it is difficult to tell whether the order in which

different morphemes reach criteria reflects differences in productivity or differences in the chances of different morphemes being sampled; it is difficult to tell whether common patterns of emergence reflect commonalities between children or the fact that all of the children's measures of emergence are subject to the same sampling effects; and it is difficult to tell whether any relations that are found between order of emergence and frequency in the input are due to real input effects or simply reflect the fact that morphemes that occur more frequently in the input are also more likely to be sampled in the child's production data. The implication is that if we are interested in finding the answers to these questions, we need to use measures of productivity that are not only sensitive to the number of different word types with which a given morpheme is used, but also to the number of opportunities that the child has to use the relevant morpheme. This is likely to be particularly challenging in languages like Japanese, in which it is much more difficult to identify obligatory contexts than it is in English.

Second, our findings illustrate the value of adopting a more probabilistic approach to the question of morphological productivity in which regression analyses are used to investigate the factors that affect the age at which particular forms appear in children's speech. This approach has the advantage that it allows the researcher to remain agnostic about whether children's use of particular morphemes is or is not productive and hence to differentiate between cases where the patterning of the data does provide strong evidence that the child's knowledge is highly productive and cases where it does not. This is likely to be particularly important in agglutinative languages like Japanese, where the researcher not only has to identify whether the child's use of a particular verb form is productive, but also the level at which it is productive. For example, does a child who can use the Stative-Past and the Completive-Past endings productively represent these endings as one morpheme or as two morphemes. One interpretation of the complex pattern of results generated in this study is that the answer to this question may be different for different complex forms. For example, it could be argued that the lack of an input effect for stative forms suggests that Japanese children represent the stative-past ending as two separate morphemes with separable meanings, whereas the strong input effect for completive forms suggests that they represent the completive-past ending as a single morpheme with a peculiar meaning of its own.

Third, our findings suggest that, where frequency in the input does predict the age at which particular forms appear in children's speech, these effects cannot be simply explained away as sampling artefacts. It is perhaps important to note at this point that the controls

employed in the present study do not completely rule out a sampling effect explanation, since they do not rule out the possibility that what is driving any effect is the likelihood that a particular verb form (i.e. a particular combination of lemma and morphemes) will occur in both the child and the caregiver's speech (as opposed to the combined likelihood that a particular lemma, a particular medial morpheme and a particular final morpheme will occur). However, by controlling for effects of lemma and morpheme frequency, they do rule out two of the more obvious confounds in previous research. Thus they provide stronger evidence for effects of form frequency in the input than many previous studies.

To conclude, the present corpus-based study of Japanese provides evidence against the validity of type-based measures of productivity and shows how a more probabilistic approach to the issue of morphological productivity can generate important insights into the way in which agglutinative morphology is acquired. These findings challenge the idea that children's inflectional knowledge becomes fully productive at some early point in development, and are consistent with the constructivist claim that the development of morphological productivity is a gradual process (e.g. Aguado-Orea & Pine, 2015; Dąbrowska, 2008 Tomasello, 2003), with some morphemes becoming highly productive relatively early in development, but others being more restricted in their use until relatively late.

Chapter 5: Comparing generativist and constructivist accounts of the use of the past tense form in early child Japanese

Rationale for the study in Chapter 5

The study reported in Chapter 5 aims to compare generativist and constructivist accounts of children's early knowledge of inflection by investigating children's early production of verb inflection in Japanese.

As explained in the introduction, much of the literature on children's acquisition of verb inflection has centred on RI errors and person-number agreement errors, which have been studied mainly from two distinct perspectives: generativist and constructivist or usage-based. Generativist theories generally assume early productive use of inflection across verbs, and postulate rules and constraints that are defined in terms of grammatical categories such as inflection or tense to explain the observed phenomena (e.g. Hyams, 2004; Wexler, 1998). On the other hand, constructivist theories emphasise the importance of input-driven leaning and predict a probabilistic distribution of correct use that reflects the distribution in the input language (e.g. Tomasello, 2003).

The first part of the study investigates the generativist proposal that the past tense inflection has a special grammatical status for the child (i.e. that this inflection is a default for the child during the early stages, and can be used across a range of contexts (e.g. Murasugi, 2015). The alternative constructivist prediction is that children's use of different inflections reflects the verb-specific distributional patterning of forms in the children's input, meaning that children's inflectional knowledge is not highly productive but rather lexically restricted (e.g. Ambridge et al., 2015; Dąbrowska and Lieven. 2005). These contrastive predictions are tested by analysing variation in children's earliest verb forms, including patterns of inflectional error and the usage pattern of past and other inflections using the naturalistic speech data of 4 Japanese children aged 1;5-2;10 from the CHILDES database (MacWhinney, 2000).

Key to this study is the use of partial correlation to identify relations between verb-specific differences in the distribution of children's verb use and that of their parents, while controlling for the semantic-distributional properties of Japanese.

1 Introduction

How children learn the system of verb inflection in their language is a long-standing question in language acquisition research (e.g. Brown, 1973; Hoekstra & Hyams, 1998; MacWhinney, 1978; Pinker, 1984; Pizzuto & Caselli, 1992; Shirai & Andersen, 1995; Tomasello, 2000; Wexler, 1994; 1998). However, work from different theoretical perspectives has tended to answer this question in very different ways. Generativist research has tended to emphasise the low frequency of inflectional errors in children's speech, and the fact that those errors that do occur tend to involve the incorrect use or over-use of one particular default-like form. Constructivist research has tended to emphasise the limited productivity of children's early use of verb inflection and the fact that children's early use of particular inflections tends to mirror the frequency statistics of the input.

The aim of the present study is to use data from early child Japanese – an agglutinative language, which shows substantial by-verb variation in the frequency with which verbs occur in different forms – to compare these two kinds of account. In order to test the first kind of account, we look for evidence that the past tense form, which has been reported to occur very early in the speech of Japanese children, has some special default-like status for the Japanese-learning child. In order to test the second kind of account, we look for evidence that by-verb variation in the children's tendency to use forms with the past tense inflection is related to by-verb variation in the relative frequency with which those verbs occur with the past tense inflection in the input. Since many previous studies have not distinguished adequately between specific effects of the input to which the child is exposed and more general effects of the semantic-distributional properties of the language being learned, we look for specific relations between the child's language use and the child's own input by partialling out the relation between each child's language use and input averaged across the caregivers of the other children in the sample.

1.1 Generativist accounts

Many generativist accounts of the development of verb inflection argue for early knowledge of inflection on the basis of the low frequency of inflectional errors in children's early speech (e.g. Hoekstra & Hyams, 1998; Wexler, 1998). According to this view, young children's largely correct use of verb morphology reflects underlying knowledge of inflection, and those errors that do occur reflect a tendency to produce Optional Infinitive (OI) or Root

Infinitive (RI) errors (i.e. non-finite forms in contexts in which a finite form is required in the adult language; see also Rizzi, 1993/1994).

Some theories of the RI stage attempt to explain why RI errors occur in some languages and not in others. For example, according to Wexler (1998), RI errors reflect a Unique Checking Constraint (UCC), which interacts with the type of language being learned to result in RI errors in obligatory subject languages such as English, Dutch French and Swedish, but not in INFL-licensed null subject languages such as Spanish and Italian. However, others have attempted to extend the idea that children make errors involving the incorrect use of a 'tenseless' verb form to languages in which RI errors do not occur. For example, Salustri and Hyams (2003) argue that, in Italian, the imperative is an RI analogue, and Grinstead, De la Mora, Vega-Mendoza and Flores (2009) argue that, in Spanish, the 3sg present tense form is an RI analogue. The concept of an RI analogue has also been extended to non-Indo-European languages. For example, Kim and Phillips (1998) argue that, in early child Korean, children's overuse of a particular mood marker is analogous to the use of RIs, and Murasugi et al. (2009) argue that, in early child Japanese, the past tense form can be viewed as an RI analogue (see also Murasugi, 2015). The key idea in all of these analyses is that there is an early stage in development, during which TENSE can be underspecified, or fail to merge with V, in the underlying representation of the sentence, and that, during this stage, children learning non-RI languages use a particular form of the verb as a 'tenseless' form in the same way that children learning RI languages use the infinitive.

The RI-analogue approach has the potential to provide a unified account of data across a wide range of different languages. However, it is subject to two potential problems. The first is that it assumes that early child language exhibits 'inflectional imperialism' (Slobin, 1985; 1216): the tendency to make errors that involve 'defaulting' to a single dominant pattern in the language. However, as Dressler (2005) points out, there is wide typological variation in the extent to which languages exhibit this property. Thus, although a common feature of weakly inflecting fusional languages such as English, it is much less common in agglutinating languages such as Turkish and Hungarian. This observation raises doubts about how far it is possible to extend the RI-analogue approach – and, in particular, about the extent to which the approach can be extended to agglutinative languages.

The second is that it is often difficult to distinguish empirically between an RI-analogue account of children's early use of verb morphology and a constructivist account that emphasises the role of input frequency (e.g. Tomasello, 2000). This is because the

hypothetical RI analogue is often the most frequent form in the input. For example, Grinstead et al. (2009) argue that, in Spanish, the 3sg present tense form is an RI analogue. However, in Spanish, the 3sg present tense form is the highest frequency form in the input (Aguado-Orea & Pine, 2015), and is also homophonous with the imperative for regular verbs. This makes it impossible to tell whether the overuse of the 3sg present tense form by Spanish children reflects its linguistic status as an RI analogue or a tendency to default to the most common form of the verb when the child is unable to generate the correct form in a particular morphological context.

In view of these considerations, the first aim of the present study is to evaluate the plausibility of the RI-analogue approach by focusing on the early use of verb inflection in Japanese — an agglutinative language which shows substantial by-verb variation in the frequency with which verbs occur in different forms. This will be done by testing Murasugi et al.'s (2009) claim that the past tense form is an RI analogue for the Japanese-learning child. More specifically, we will investigate: 1) whether there is any evidence of a special preference for past tense forms in Japanese children's early verb vocabularies; and 2) whether the errors produced by Japanese children tend to involve the over-use of past tense forms.

1.2 Constructivist accounts

Constructivist accounts of the development of verb inflection have tended to emphasise the limited productivity of children's early use of verb morphology and the fact that children's early use of particular inflections tends to mirror the frequency statistics of the input (e.g. Pizzuto & Caselli, 1992; Tomasello, 2000). According to this view, young children's correct use of verb morphology reflects knowledge that is initially embedded within particular lexically-restricted patterns, and those errors that do occur reflect a tendency to use the form of the verb that occurs most frequently in the input language.

There is already considerable evidence that children's early verb learning and use is related to the frequency with which particular verbs occur in the input. For example, Smiley and Huttenlocher (1995), Naigles and Hoff-Ginsberg (1998) and Theakston et al. (2004) all report significant relationships between the frequency with which particular verbs occur in the input language and the order in which they emerge in the child's speech (see Ellis (2002) and Ambridge et al. (2015) for reviews of the data on frequency effects in language learning). Evidence has also recently emerged that it is possible to explain the relative frequency with which young children produce particular forms of the verb in terms of the relative frequency

of particular forms in the input language. For example, Freudenthal et al. (2010) have shown that it is possible to explain by-verb differences in the rate at which children make RI errors in a range of languages in terms of the relative frequency of infinitive versus finite forms of the verb in English, Dutch, French, German and Spanish, and Räsänen et al. (2014) have shown that it is possible to explain by-verb differences in the rate at which children produce RI errors in English in terms of the relative frequency of bare stem versus 3sg forms in the input.

However, a particular challenge facing constructivist analyses is how to disentangle effects of input frequency on children's learning and effects of sampling and/or of the semantic-distributional properties of the language being learned. With respect to the first of these issues, Tomasello and Stahl (2004) point out that analyses based on naturalistic speech samples tend to confound order of acquisition with frequency in the language, such that forms that occur with high frequency in the language are likely to be sampled earlier than forms that occur with lower frequency in the language, even if both forms were acquired by the child at the same time. This problem makes it difficult to distinguish between true effects of input frequency on learning and spurious effects that actually reflect differences in the likelihood that particular items will be sampled in naturalistic data.

A similar point can be made about measures of the relative frequency with which verbs occur in particular forms in the children's speech. Thus, it may be tempting to take correlations between the relative frequency with which particular verbs are used in particular forms by the child and by the caregiver as evidence of input-driven learning. However, as Yang (2013) points out, some words are more likely to be used in some contexts rather than others because of the semantic distributional properties of the language. For example, in English, one is more likely to use the word *bath* with the indefinite article *a* than the definite article *the* because baths are things that one *has* or *takes*, and more likely to use the word *bathroom* with the definite article than the indefinite article, because *bathrooms* are locations which one tends to *go to* or *visit*. This kind of patterning makes it difficult to distinguish between real effects of input frequency on learning and spurious effects that simply reflect the fact that all speakers of the language are more likely to use some words in one way rather than another.

In view of these considerations, the second aim of the study is to test an input-driven account of Japanese children's use of past tense forms while controlling for the effects of sampling and/or the semantic-distributional properties of the language being learned. This

will be done by looking for dyad-specific effects of the relative frequency of past tense and other inflectional forms in the input, while controlling for the effects of relative frequency in data averaged across the other caregivers in the sample. The rationale for this approach is that it has the potential to identify effects of the child's input over and above effects of input from the average mother — effects which therefore cannot be explained in terms of general differences in the likelihood of particular verbs occurring in the past tense as opposed to other inflectional forms in the input language. Although one can argue that the individual caregiver's input is not representative of a child's real input because children are exposed to the input language from multiple sources including speech from other people and medias such as TV, this approach allows us to focus on the effect of caregiver's personal usage pattern of verb forms on child's speech. Note that Japanese is particularly well suited to this kind of analysis because both the past and nonpast verb forms occur frequently in both Japanese child-directed speech and in Japanese children's early production data (e.g. Clancy 1985; Shirai, 1998). This makes it possible, at least in principle, to distinguish between by-verb variation that reflects the general properties of child-directed Japanese and by-verb variation that reflects the specific properties of the speech to which particular children are exposed. We now provide a brief sketch of Japanese syntax and morphology.

1.3 A brief sketch of Japanese syntax and morphology

Japanese is a typical head-final language, with features such as verb-final word order, attributive-noun word order, and the use of postpositional case markers. The basic word order is SOV, but the order of nominal arguments is pragmatically conditioned and relatively free in spoken discourse — a phenomenon often referred to as 'scrambling' (see Shibatani, 1990). Nominal arguments are also frequently left unexpressed. This can make it difficult for the researcher to infer speakers' communicative intentions from spoken discourse, especially in the case of young language-learning children. It also means that it is more difficult to identify obligatory contexts for particular verb inflections in Japanese than it is in English.

Japanese verbs have agglutinative morphology with extensive use of suffixation to mark inflectional distinctions. Finite verbs are always inflected for tense. However, unlike many Indo-European languages, Japanese does not have subject-verb agreement. A basic form consists of a stem and a tense marker as in *tabe-ru* 'eat-NONPAST' and *tabe-ta* 'eat-PAST'. However, verb forms can also be more complex with morphological processes such as derivation, inflection and concatenation. Note that past versus nonpast is the only tense

distinction in Japanese, with past tense forms being used to refer to past events and nonpast forms being used to refer to both present and future events. Bare verb roots or stems are not well formed as words in Japanese, and are never produced as such. Nor does Japanese have infinitive forms like those in European languages such as German, French and Spanish. Table 12 shows some basic inflectional distinctions and the suffixes that encode them for two major morphological classes: verbs where the stem ends in a consonant and verbs where the stem ends in a vowel. The former show stem alternation, which is dependent on whether or not they are followed by an auxiliary. Note that Table 12 does not provide a comprehensive

Table 12. Some basic inflectional forms in Japanese

	kik- 'listen' (consonant-ending verb)	*mi-* 'look at' (vowel-ending verb)
Nonpast	*kik-u*	*mi-ru*
Past	*kii-ta*	*mi-ta*
Conjunctive/imperative	*kii-te*	*mi-te*
Conditional	*kik-e-ba*	*mi-re-ba*
Cohortative	*kik-oo*	*mi-yoo*
Passive Nonpast	*kik-a-re-ru*	*mi-rare-ru*
Causative Nonpast	*kik-a-se-ru*	*mi-sase-ru*
Potential Nonpast	*kik-e-ru*	*mi-(ra)re-ru*
Progressive Nonpast	*kii-te-ru*	*mi-te-ru*
Negative Nonpast	*kik-a na-i*	*mi na-i*

description of Japanese verb inflection. It simply provides the reader with some information about the most common forms that Japanese speakers produce. Children are therefore typically exposed to a wider range of forms than those in Table 12 (see Shibatani (1990) for a more detailed description of Japanese verb morphology).

Previous studies of verb inflection in early child Japanese have reported that Japanese-speaking children typically use a number of different inflections by the age of two years, although some of these inflections may not be handled productively (e.g. Clancy, 1985; Rispoli, 1981). Clancy lists the inflectional forms that children tend to acquire early. These are: V-*te* imperative, V-*ta* past, V-*teru* nonpast progressive, V-*ru* nonpast, V-*chatta* completed past, V-*nai* negative nonpast, V-*tai* desiderative nonpast (Clancy, 1985: 426, with glosses modified by the current authors). Shirai (1998) and Shirai and Miyata (2006) report frequent use of both the past and the nonpast inflection during the early stages. However, they also report individual variation in acquisition profiles, which is consistent with the idea that it may be possible to find dyad-specific input effects on Japanese children's early use of verb morphology. Murasugi et al. (2009), on the other hand, argue that there is an initial stage in early child Japanese in which children only use past tense verb forms in their speech.

1.4 The present study

The aim of the present study is to investigate children's early use of verb inflection in Japanese by comparing the idea that the past tense form has a special default-like status for the Japanese-learning child with the idea that Japanese children's use of past tense forms reflects the relative frequency with which particular verbs occur in past tense form in their input. The RI-analogue account will be tested by looking for evidence that Japanese-speaking children show a particular preference for past tense forms during the early stages, and a specific tendency to overuse past tense as opposed to other inflectional forms of the verb in their early speech. The input-driven account will be tested by looking for by-verb effects of the relative frequency of past tense and other inflectional forms in the child's input on the relative frequency with which they use past tense forms in their speech, while controlling for general differences in the relative frequency with which verbs occur in past tense form in Japanese child-directed speech.

2 Method

2.1 Corpora

The data used in the present study were those of 4 Japanese-speaking children and their caregivers: three children (Aki, Ryo and Tai) from the Miyata corpus (Miyata, 2004a, 2004b, 2004c) and one child (Jun) from the Ishii corpus (Ishii, 2004). Both of these corpora are available in the CHILDES database (MacWhinney, 2000). The Miyata corpus consists of

transcripts of parent–child interaction (predominantly mother-child interaction) recorded in the normal home environment. The children were recorded at weekly intervals, except for Aki's recordings between 1;5 and 1;11, which were conducted at monthly intervals. Each recording session lasted between 30 and 60 minutes. The Ishii corpus consists of transcripts of parent-child interaction recorded twice a month between 0;6 and 3;8, with each recording lasting approximately 15 minutes for the first half of the corpus and approximately 60 minutes for the second half.

The data for the present study were taken from a 12-month period starting from the point at which the first verb was observed in each child's corpus. Aki's first verb appeared at 1;8, Ryo's first verb appeared at 1;10 and Jun's first verb appeared at 1;8. Tai was already using verbs in his first recording at 1:5. Unintelligible utterances, imitations and repetitions were excluded from the analysis. Unintelligible utterances were defined as utterances in which any portion of the utterance was marked as unintelligible (i.e. 'xxx') in the transcript. Imitations were defined as utterances that consisted entirely of material that had occurred in one of the two immediately preceding adult utterances. Repetitions were defined as utterances that consisted entirely of material that had occurred in one of the two immediately preceding child utterances. This process was designed to minimise direct effects of the child's verb use on the parent's very use. However, it should be noted that it does not allow us to rule out all possible alternative explanations of potential input effects. For example, it does not rule out the possibility that they may reflect more subtle effects of the child on the caregiver, such as lexical priming effects, indirect effects of parental sensitivity to the child's interests, or commonalities in the pragmatic contexts from which the child and caregiver speech samples were drawn. After these exclusions, the total number of child utterances in each dataset was 14,417 for Aki, 10,002 for Ryo, 14,575 for Tai and 17,611 for Jun and the total number of utterances that included a verb was 2,510 for Aki, 2,772 for Ryo, 4,760 for Tai and 3,702 for Jun. The input data used in the analysis were all drawn from the speech of the children's caregivers. For Aki, Ryo and Tai, this was the mother. However, in Jun's case, input data from both the mother and the father were included as the father was the child's main interlocutor in many of the transcripts.

2.2 Analyses

The corpus data described above were analysed in the following ways. All verb forms, with the exception of subsidiary verbs (e.g. *miru* in *itte miru* go-CONNECTIVE see-

NONPAST '(try to) go')) and irregular verbs (e.g. *nai* 'not be' and *kudasai* 'please'), were extracted from the corpora. In the case of the Miyata corpus, this was done by searching for verb forms on the morphological coding tier of the transcripts. In the case of the Ishii corpus, which is not morphologically coded, this was done by directly coding the transcripts themselves. These data were then used to identify the first 10 verb forms in Aki, Ryo and Jun's speech and to calculate the proportion of these that were past tense forms. Tai's data were not analysed in this way because he was already using verbs in his first recording sessions. They were also used to identify the first 50 verb roots in each of the children's speech and to calculate the proportion of both child and caregiver uses of each of these verb roots that was marked for past tense. The children's verb uses were also coded for morphological errors. This was done by hand-coding each of the child's verb uses in context, and identifying cases in which the child used a particular form of the verb in an inappropriate morphological context (e.g. a past tense form in a nonpast tense context or vice versa). These measures were then used to test the RI-analogue account and the input-driven account as follows.

The RI-analogue account was tested by:

1) Identifying the first 10 verb forms that appeared in Aki, Ryo and Jun's data and calculating the proportion that were past tense forms;
2) Identifying any inflectional errors made by the children, and calculating the proportion that involved the inappropriate use of a past tense form and the proportion that involved the inappropriate use of other inflectional forms.

These analyses are designed to establish whether the past tense form had a special default-like status for the Japanese-learning child.

The input-driven account was tested by:

1) Calculating the rate at which each of the child's first 50 verbs occurred in past tense as opposed to some other form in the child's speech;
2) Calculating the rate at which each of these verbs occurred in past tense as opposed to some other form in the caregiver's speech;
3) Computing simple correlations between the by-verb rate of past tense forms in the child and caregiver's speech and partial correlations that controlled for the average rate at which past tense forms occurred in the speech of the other 3 caregivers. In each

case, the relevant proportional measures were arcsine transformed to ensure that they met parametric testing assumptions.

This approach was designed to allow us to identify dyad-specific effects of the proportion of past tense forms in the child's input, controlling for effects of the general frequency statistics of Japanese child-directed speech. It should be noted that, since Japanese has agglutinative verb morphology, and it is unclear whether children distinguish between past tense inflections in simple past (i.e. verb root + past tense) and complex past tense forms (i.e. verb root + other suffix(es) + past tense), no distinction was made between simple and complex past tense forms in any of the above analyses.

3 Results

3.1 Testing the RI-analogue account

The key prediction of the RI-analogue account is that the past tense form will have a special default-like status for the Japanese-learning child. One way of operationalizing this prediction is to focus on the earliest inflectional forms that children produce. For example, the RI-analogue account would seem to predict a preponderance of past tense forms in the children's early verb vocabularies. A second is to look at the kind of inflectional errors that children produce. For example, the RI-analogue account would seem to predict that the majority of inflectional errors made by the child will involve the over-use of past tense forms.

Earliest inflectional forms

Table 13 provides details of the first 10 verb forms to appear in Aki, Ryo and Jun's corpora. It can be seen from Table 13 that, although, for all these children there are some past tense forms amongst these first 10 verb forms, there is no real evidence of a particular preference for past tense forms in the children's data, with all of the children producing a range of different inflectional forms, including past tense forms, nonpast tense forms, and imperatives, and with past tense forms only accounting for between 4/10 and 5/10 forms in each case.

These results are consistent with those reported by Shirai (1998) in an analysis that included one of the same 3 children (Aki). What they seem to reflect is not a verb-general preference for the past tense form, but a tendency to acquire high frequency forms that are pragmatically useful from the child's point of view. For example, the past tense form of the verb *ar-* 'be' appears very early in all of the children's data. This form means 'be-

PAST=was', and can occur in utterances such as *hon-wa tukue-no ue-ni atta* (book-TOPIC desk-GENITIVE top-LOCATIVE be-PAST) 'The book was on the table.' However, it can also be produced as a single-word utterance: *Atta!* (be-PAST) 'was' in object-finding contexts, where it is the equivalent of the English utterance 'There it is!' The early appearance of this form in all 3 children's speech therefore probably reflects its usefulness for drawing the caregiver's attention to interesting objects.

Table 13. The first 10 verb forms in Aki, Ryo and Jun's corpora

Aki			Ryo		
Age	Verb form	Meaning	Age	Verb form	Meaning
20	*atta*	be-PAST	22	*atta*	be-PAST
	miru	see-NONPAST		*dechatta*	get.out-COMPLETIVE-PAST
22	*iku*	go-NONPAST		*deta*	get.out-PAST
24	*doite*	step.aside-IMPERATIVE	23	*yatte*	do-IMPERATIVE
	aru	be-NONPAST		*haitta*	enter-PAST
	mieta	be.in.sight-PAST		*i nai*	be-NEG-NONPAST
25	*tatte*	stand-IMPERATIVE		*aru*	be-NONPAST
	deta	get.out-PAST		*deru*	get.out-NONPAST
	itchatta	go-COMPLETIVE-PAST		*haira nai*	enter-NEG-NONPAST
	dete	get.out-CONNECTIVE		*tot-te*	take-IMPERATIVE

Jun		
Age	Verb form	Meaning
20	*atta*	be-PAST

22	*sita*	do-PAST
23	*itchatta*	go-COMPLETIVE-PAST
	itte	go-CONNECTIVE
	site	do-CONNECTIVE
25	*ita*	be-PAST
	aru	be-NONPAST
	mita	see-PAST
26	*matte*	wait-CONNECTIVE
27	*chigau*	be.different-NONPAST

A similar point can be made about the imperative forms that appear in the children's data. The verbs that appear in imperative form in the children's data tend to be action verbs, such as *tot-te* (take-IMPERATIVE), which can be translated as 'Pass me (that),' and *doi-te* (step.aside-IMPERATIVE), which can be translated as 'Get out of the way'. These forms are common in the input, and their early appearance in the children's speech probably reflects the fact that they are useful for manipulating other people's behaviour.

In short, the data presented in Table 13 are consistent with the idea that what determines the nature of the children's earliest inflectional forms is not a general preference for the past tense form, but a tendency to acquire the inflectional form of the verb that is most pragmatically salient in the input. These data thus provide no real support for the RI-analogue account.

3.2 Inflectional errors

Table 14 provides details of the rates of inflectional errors in each of the 4 children's corpora. It can be seen from Table 14 that inflectional errors are extremely rare in all of the children's data. These very low error rates are at least partly a reflection of the fact that it is more difficult to identify obligatory contexts for particular verb inflections in Japanese than it

is in English. They also collapse across relatively long periods of development and may therefore hide higher error rates during the early stages. Nevertheless, it is clear from Table 14, that the few inflectional errors that it is possible to identify in the children's speech include at least as many instances of the overuse of nonpast tense forms as they do of past tense forms.

Table 14. Rates of inflectional errors in the 4 children's data

	Aki	Ryo	Tai	Jun
Past	11/545 (2.02%)	4/263 (1.52%)	2/1281 (0.16%)	3/612 (0.49%)
Nonpast	26/1034 (2.51%)	5/439 (1.14%)	3/2390 (0.13%)	4/925 (0.43%)
Connective	8/114 (7.02%)	3/68 (4.41%)	3/753 (0.40%)	1/104 (0.96%)
Imperative	5/240 (2.08%)	1/140 (0.71%)	0/520 (0%)	0/254 (0%)
Total	50/1933 (2.59%)	13/910 (1.43%)	8/4944 (0.16%)	8/1895 (0.42%)

These results are consistent with those presented in a similar analysis by Kato et al. (2003), which included two of the same children (Ryo and Tai), and provide no real support for the claim that the past tense form has a special status for the Japanese-learning child. On the contrary, what the inflectional errors produced by the children seem to reflect is the use of a high frequency form of the verb (whether it be a past tense form, a nonpast tense form, or some other form) in a context in which a lower frequency form is required. Thus, on the one hand, Aki produced the past tense form *not-ta* (get.on-PAST) '(he) got on' when he was told by his mother that his brother was on the train. The most natural form to use in this context is *not-te-ru* (get.on-ASPECTUAL-NONPAST) 'he is (riding) on the train', but the past tense form *not-ta* is more frequent in Aki's mother's input (accounting for 92 of a total of 295 tokens) than the target form *not-te-ru* (41 out of 295 tokens). On the other hand, Aki also produced the opposite kind of error. For example, he produced the nonpast tense form (*iw-u* say-NONPAST) in the utterance *nani Suuze iwu?* (what Suuze (person name) say-NONPAST) 'What does Suuze say?' instead of using the past tense form *it-ta* (say-PAST) when he asked his mother what Suuze had said a moment before. In this case, the nonpast tense form *iw-u* is the most frequent form of the verb in Aki's mother's data (accounting for

41 of a total of 81 tokens), whereas the target form *it-ta* is much less frequent (9 out of 81 tokens). These examples are consistent with the idea that what determines the nature of the children's early inflectional errors is not a general preference for the past tense form, but a tendency to overuse the inflectional form of the verb that occurs most frequently in the input.

To summarise, neither the data on the children's earliest inflected forms, nor the data on their inflectional errors or the proportion of past tense forms in their early speech provide any real support for the RI-analogue account. What these data do seem to suggest is that the children's early verb use is influenced by the relative frequency with which different forms of the verb occur in the children's input. It is therefore to an analysis of the relation between children's early verb use and the input that we now turn.

3.3 Testing the input-driven account

Table 15 presents data on the proportional frequency with which each of the children and their caregivers produced each of the children's first 50 verbs in past tense form. It is clear from Table 15 that past tense forms make up a substantial proportion of both the adults' and the children's uses of these verbs (.20 to .28 and .22 to .42, respectively). However, it is also clear that they make up a higher proportion of the children's than the adults' uses in all 4 dyads, with the difference ranging from .02 in the case of Ryo to .14 in the case of Aki.

Table 15. Means and standard deviations for the proportion of past tense forms in the children and their caregivers' use of the child's first 50 verbs

	Child			Caregiver		
	Mean	SD	Range	Mean	SD	Range
Aki	0.42	0.36	0-1	0.28	0.23	0-0.79
Ryo	0.29	0.26	0-1	0.28	0.26	0-1
Tai	0.32	0.28	0-1	0.27	0.25	0-0.87
Jun	0.22	0.26	0-1	0.20	0.22	0-0.85

These differences were analysed using paired-sample t-tests, which revealed significant differences for Aki and Tai (both *t*s > 2.04 both *p*s < .05), but not for Ryo and Jun (both *t*s < .82, both *p*s > .42). These results therefore provide some support for the idea that Japanese children may be particularly sensitive to past tense forms in the input (and are hence arguably consistent with an RI-analogue account). However, it is also clear from Table 15 that there is considerable by-verb variation in the proportion of past tense forms in the children's and the adult's verb use, with some verbs never occurring in past tense form and others occurring in past tense form 100% of the time.

Table 16 presents simple correlations between the proportional frequency of past tense forms across the first 50 verbs, in the speech of the children, their caregivers and the average caregiver. It can be seen from Table 16 that there are significant correlations for all of the children and their respective caregivers (all *r*s > .33, all *p*s < .02, two-tailed), suggesting that a key determinant of the extent to which children use verbs in past tense form is the relative frequency with which those verbs occur in past tense form in the input language. However, it can also be seen from Table 16 that there are significant correlations for 3 of the 4 children with the average caregiver (all *r*s > .34, all *p*s < .02, two-tailed), the exception being Jun ($r = .17$, $p = .24$). This pattern of correlations underlines the need to control for general by-verb differences in the relative frequency of past tense forms in the target language before taking significant correlations between their relative frequency in the children and their caregivers' speech as evidence of direct effects of the input on the children's early verb use.

Table 16. Simple correlations between children and caregivers' proportional use of past tense forms for each of the child's first 50 verbs

		Aki	Ryo
Child and child's caregiver	Pearson Correlation	.599	.883
	Sig. (2-tailed)	.001	.001
	df	48	47
Child and average input	Pearson Correlation	.392	.346

	Sig. (2-tailed)	.005	.014
	df	48	48
		Tai	Jun
Child and child's caregiver	Pearson Correlation	.677	.337
	Sig. (2-tailed)	.001	.018
	df	48	47
Child and average input	Pearson Correlation	.511	.173
	Sig. (2-tailed)	.001	.238
	df	48	46

In order to control for this kind of general effect of the target language, partial correlations were computed between the proportional frequency of past tense forms across verbs in the children and their caregivers, while controlling for the average proportional frequency of past tense forms across verbs in the other 3 caregivers. These partial correlations are presented in Table 17, from which it can be seen that there are dyad-specific effects in all 4 cases (all rs > .31, all ps < .04, two-tailed).

Table 17. Partial correlations for each of the 4 child-caregiver pairs, controlling for relative frequency in the input averaged across the other 3 caregivers

Correlation between	Correlation	Significance (2-tailed)	df
Aki and Aki's mother	0.492	<.001	47
Ryo and Ryo's mother	0.851	<.001	46
Tai and Tai's mother	0.523	<.001	47
Jun and Jun's parents	0.318	.031	44

These results suggest that, rather than reflecting by-verb variation in the likelihood that particular verbs will occur in past tense form in the target language, the relationship between the children and their caregivers' use of past tense forms reflects a direct effect of the relative frequency with which different verbs occur in past tense form in the children's input. They thus provide strong support for an input-driven account of Japanese children's early use of verb inflection.

4 Discussion

The aim of the present study was to investigate the early use of verb inflection in Japanese by testing the hypothesis that the past tense form is an RI analogue, and contrasting it with the alternative hypothesis that children's use of past tense versus other inflectional forms reflects the distributional patterning of past tense and other inflectional forms in the input. On the one hand, our results provide little support for the RI-analogue account. Thus, all of the children used a range of forms during the earliest stages of acquisition, and all of the children produced errors involving the overuse of a range of inflectional forms. On the other hand, our results do provide support for an input-driven account, with all of the children showing by-verb effects of the proportion of past tense versus other inflectional forms in their input on the proportion of their first 50 verbs that appeared in past tense form even after controlling for differences in the proportion of past tense versus other inflectional forms in input averaged across the caregivers of the other children in the sample.

These results have a number of implications for our understanding of early morphological development. First, they raise doubts about recent attempts to explain children's early use of verb morphology in non-RI languages in terms of a hypothetical RI-analogue stage. For example, Salustri and Hyams (2003) argue that, in Italian, the imperative is an RI analogue; and Grinstead et al. (2009) argue that, in Spanish, the 3sg present tense form is an RI analogue. Within such accounts, the choice of default form is assumed to be linguistically motivated. However, the imperative in Italian is also a relatively high frequency form that is homophonous with the 3sg or 2sg present tense form depending on the conjugation of the verb; and the 3sg present tense in Spanish is both the highest frequency form in the input (Aguado-Orea & Pine, 2015), and also homophonous with the imperative for regular verbs. These facts make it difficult to distinguish empirically between an RI-analogue account of children's early use of verb morphology and a constructivist account that emphasises the role of input frequency, since they mean that the hypothetical RI analogue is

likely to be the most frequent form of most, if not all, of the verbs in the input. Focusing on a language like Japanese, however, offers a way of distinguishing more clearly between these two types of account, since the relatively balanced frequency of past and nonpast tense forms in the input results in significantly more by-verb variation in the form in which individual verbs occur most frequently, with some verbs occurring more often in past tense form, and others occurring more often in nonpast tense form. What the results of the present study suggest is that when one does focus on such a language, one does not find the verb-general pattern of use predicted by the RI-analogue account, but the verb-specific pattern predicted by a constructivist account. The implication is that, to the extent that children do default to a particular form in their language, this may have more to do with the relative frequency of that form in the input than with its linguistic status as an RI analogue within the child's system. Räsänen et al. (2015) present evidence from a sentence elicitation study in favour of exactly this kind of account of the pattern of defaulting errors in early child Finnish. One way of extending the findings of the present study would be to use a similar elicitation paradigm to look for verb-specific patterns of defaulting error in early child Japanese. The prediction would be that Japanese-speaking children would default from nonpast tense to past tense forms for verbs that are more frequent in past tense form in the input, and from past tense to nonpast tense forms for verbs that are more frequent in nonpast tense form in the input.

Second, our results underline the need to control for general effects of the frequency and semantic distributional properties of the language to be learned when investigating the relation between input frequency and children's early acquisition and use of particular forms in naturalistic speech samples. Many previous studies of this relation (e.g. Freudenthal et al., 2010; Naigles & Hoff-Ginsberg, 1998; Rowland et al., 2003; Smiley & Huttenlocher, 1995; Theakston et al., 2004) have taken correlations between the frequency of particular forms or sequences in the input and the order in which those forms or sequences appear in children's speech, or between the relative frequency of different forms in the input and the relative frequency of those forms in the child's language, as evidence of direct effects of input frequency on children's acquisition and use of language. However, it has become increasingly clear in recent years that measures of order of acquisition based on naturalistic speech samples are confounded with the frequency of words and sequences in the language, and measures of the relative frequency with which children use particular forms are confounded with the semantic distributional properties of the language that they are learning. These problems imply the need to control for general differences in the frequency of words and sequences in the language and for the semantic distributional properties of the language

being learned before taking relations between input frequency and order of emergence or between relative frequency in the input and relative frequency in the child's language as evidence for direct effects of input frequency on language learning.

Third, our results illustrate how it is possible to control for these potential confounds by looking for specific effects of the child's own input over and above the effects of input data averaged across caregivers. Note that this approach does not rule out all possible alternative explanations of potential input effects. For example, it does not rule out the possibility that they might reflect more subtle effects of the child on the caregiver. However, it does allow us to isolate dyad-specific relations and hence to control for general frequency differences and for general semantic-distributional properties of the language being learned. It may also be particularly useful in the study of agglutinative languages, which do not tend to show the 'inflectional imperialism' typical of languages such as English (Dressler, 2005), and in which there is therefore likely to be considerable by-verb variation in the forms in which particular verbs are most likely to occur.

To conclude, the findings of the present study provide evidence against an RI-analogue account and in favour of an input-driven account of Japanese children's use of verb inflection. Although there are a number of factors that are likely to influence children's early verb use, our results suggest that Japanese-learning children are sensitive to the relative frequency of different inflectional forms in their parents' speech rather than just the semantic-distributional properties of the language being learned. Future work should attempt to rule out alternative explanations of these results by replicating them experimentally, as well as investigating the influence of additional factors such as semantic and pragmatic salience on the relative frequency with which particular forms of the verb are used.

Chapter 6: Testing an input-based account of children's errors with inflectional morphology: An elicited production study of Japanese.

Rationale for the study in Chapter 6

The study reported in Chapter 6 follows up on the results reported in Chapter 5, which provided support to the input-based learning view by conducting a series of descriptive and statistical analyses on the use of past tense and other inflections in children's naturalistic speech data. To strengthen this argument, the study reported in Chapter 6 conducts an elicited production experiment using a sentence completion task in order to test generativist and constructivist predictions about children's use of verb inflections. The experimental approach allows this study to control for sampling effects and to observe errors that are difficult to identify in naturalistic speech data.

One of the major problems in contrasting generativist and constructivist account in this area is the difficulty of distinguishing between forms that are frequent and forms that are considered to have some special grammatical status for the child. For instance, in English, the bare/infinitive is so frequent that it is the most frequent inflectional variant for almost every verb (e.g. Räsänen et al., 2014). This situation is less than ideal for studying the development of inflection as it makes it difficult to tell whether children's over-use of the bare/infinitive form reflects is frequency in the input of its categorical status as, for example, a non-finite form. The key to solving this problem in the present study is to focus on the two most basic and frequent finite verb inflections in Japanese; the nonpast and past tense inflections (e.g. *tabe-ru* (eat-NONPAST) 'eat' and *tabe-ta* (eat-PAST) 'ate'). Since the relative frequency of these inflections varies across verbs in the input, it is predicted that children will show a bi-directional error pattern in which they misuse past forms in nonpast contexts for some verbs and nonpast forms in past contexts for other verbs. In addition, the likelihood of these errors in children's production is expected to reflect their relative frequency in the input on a verb-to-verb basis. These predictions are tested by analysing the results from two experiments that tested 48 Japanese-speaking children in total.

1. Introduction

A key prediction of input-based accounts of morphological development is that the pattern of errors in young children's speech will reflect the frequency distribution of different forms in the input. For instance, children's verb inflection errors tend to involve the use of a higher frequency form of the verb when a lower frequency form is required. Several recent studies have found support for this prediction (e.g. Matthews & Theakston, 2006; Räsänen et al., 2014; 2015; Aguado-Orea & Pine, 2015). However, the results of these studies are not definitive because of the distributional properties of the languages that have been studied thus far. Languages such as English or Spanish, with a uniform error pattern in which forms of a particular category are used instead of forms of some other categories across verbs (e.g. the bare verb form – e.g. *play* – in place of the 3rd person singular form – e.g. *plays*), are not ideal for comparing input-based accounts of children's errors against other possible accounts, such as those based on the notion of morpho-syntactic defaulting (e.g. from tense-marked to tenseless forms, e.g. *He plays* → **He play*; see Wexler, 1998).

The aim of the present study is to conduct perhaps the strongest test yet of the idea that young children's errors occur when high-frequency forms outcompete lower-frequency forms, by focusing on Japanese: a language in which there is considerable by-verb variation in the relative frequency with which verbs occur in different inflectional forms. In Japanese, in which all finite verbs are inflected for one of the two tense categories (past and nonpast), some verbs occur considerably more frequently in the past than nonpast form, with others showing the opposite pattern. Input-based accounts therefore predict a bi-directional error pattern such that children will incorrectly use past tense forms in nonpast contexts and nonpast tense forms in past contexts, with the by-verb patterning of these errors predicted by the relative frequency with which the relevant verb occurs in these two inflectional form in the input. The present study tests this hypothesis using an elicited production methodology.

1.1 Effects of frequency on children's errors

The assumption that children's use and misuse of inflectional verb forms reflects the distributional properties of the input is central to input-based accounts of language acquisition. Input-based accounts are most associated with a constructivist view of acquisition (e.g. Ellis, 2002; Tomasello, 2003; Bybee, 2006), but also include generativist accounts that assume at least some role for competition between stored forms (e.g. Prasada & Pinker, 1993; Alegre & Gordon, 1999; Clahsen, 1999; Albright & Hayes, 2003; Hartshorne & Ullman, 2006).

Because, on this view, the learning process is fundamentally dependent on experience, frequency is considered a key explanatory factor for many different learning phenomena; and, indeed, the importance of this factor has been demonstrated empirically for many different domains (see, e.g. Ellis, 2002; Ambridge et al., 2015, for reviews). The mechanism behind learners' errors, including those that reflect the use of one inflectional form instead of another, is also assumed to be sensitive to input frequency. One of the effects of frequency is an increase in accessibility (Bybee, 1991; 2006; 2007): a form becomes more accessible as we experience that form repeatedly. This means that some linguistic forms become more accessible than others because of the difference in their frequency of occurrence in everyday language use. Indeed, *relative* input frequency, which represents the balance of accessibility or representational strength between different forms, has been shown to be a significant predictor of the errors that children produce when they have difficulty in accessing or retrieving the target form. For example, Räsänen et al. (2014) demonstrated that children's errors of using bare/infinitive forms (e.g. **He play*) instead of 3sg inflected forms (e.g. *He plays*) involve a frequency-based competition process, by showing that the relative frequency of bare/infinitive versus 3sg *–s* forms predicts children's error rate across verbs.

A similar phenomenon is reported in other languages. Spanish-learning children sometimes make subject-verb agreement errors in which they use the more frequent 3rd person singular (3sg) form in a non-3sg context (Radford & Ploening-Pacheco, 1995; Clahsen, Aveledo & Roca, 2002; Aguado-Orea & Pine, 2015). The same kind of error is also observed in Catalan (Clahsen, et al., 2002), Italian (e.g. Guasti, 1993; Pizzuto & Caselli, 1992) and Finnish (e.g. Räsänen et al., 2015). To summarise, the frequency distribution of different inflectional forms of the same verb in the input is shown to be a powerful predictor of children's morphological errors in different languages; a finding which has been argued to support an input-based view of language acquisition.

1.2 Problems with the evidence for an input-based account

Although suggestive, the evidence summarised above does not yet constitute compelling support for an input-based view over rival accounts. This is because, for each of the languages and morphological systems studied so far, the balance between competing forms in the input is relatively similar across different verbs. For example, although the 48 English verbs used by Räsänen et al. (2014) varied considerably as to the *extent* of this bias, *every* verb was more frequent in bare than 3sg *–s* form. The situation is similar for Spanish,

where the 3sg present tense form (which children sometimes use incorrectly in other contexts) is not only (a) the highest frequency form for the majority of verbs but also (b) the phonologically simplest form and (c) – for regular verbs – homophonous with the highly frequent imperative (Aguado-Orea & Pine, 2015).

The properties of these languages therefore make it difficult to determine whether the overuse of a particular inflectional form by children reflects the outcome of a frequency-based competition process (with, perhaps, an additional role for phonology), or the operation of some kind of morpho-syntactic default. This latter concept originates in generativist theories of acquisition (e.g. Radford & Ploening-Pacheco, 1995; Grinstead, 1998, Wexler, 1998; Wexler, Schaeffer & Bol, 2004), and is a form that surfaces whenever – for whatever reason – the system is unable to assign (or "check") tense (e.g. present) and agreement (e.g. 3rd person singular). On this view, the reason that – for example – English children produce bare forms in 3sg contexts (e.g. **He play*) is not that the bare form (*play*) is more frequent in the input than the 3sg form (*plays*), but that children pass through a stage in which they cannot assign both tense and agreement, and so default to the bare, nonfinite form instead (e.g. Wexler, 1998). A similar argument can be made for Spanish, with 3sg as the default form (Radford & Ploening-Pacheco, 1995; Grinstead, 1998) and, as we will see, for Japanese, with past-tense as the default form.

One way to distinguish frequency-based competition from morpho-syntactic defaulting is to examine a linguistic system in which individual verbs differ with regard not only to the *relative* input frequency of two inflectional forms (e.g. past vs present), but also to *which form* is more frequent (i.e., past > present for some verbs, present > past for others). If children make errors in both directions, in a way that is systematically related to the input, it would be difficult to argue that these errors reflect morpho-syntactic defaulting, as opposed to probabilistic frequency-based competition between different forms of the relevant verb. The present study therefore focuses on Japanese, a language with a relatively complex verb system that shows exactly this property.

1.3 Japanese verb morphology

Japanese has a relatively complex verb system that makes extensive use of suffixation to mark inflectional distinctions. Finite verbs are always inflected for tense (nonpast or past); therefore, a basic form consists of a stem and tense marker, as in *tabe-ru* 'eat-NONPAST'

and *tabe-ta* 'eat-PAST' [1] (Japanese has neither infinitive forms nor subject-verb agreement). Crucially for our purposes, the frequency distribution of past vs nonpast forms varies from verb to verb. For example, for *tabe*, 'eat', the nonpast form *taberu* (70 tokens) is more frequent than the past form *tabeta* (30 tokens). Conversely, for *wakar,* 'understand', the past form *wakatta* (149 tokens) is more frequent than the nonpast form *wakaru* (100 tokens). Thus even if we restrict ourselves to basic past and nonpast forms (the two most frequent forms), the frequency distribution varies substantially across verbs. Unlike, for example, English bare versus 3sg forms (where the former is more frequent for every verb), neither form – past or nonpast – is dominant in a verb-general manner. This verb-specific, bi-directional probabilistic patterning is key to the current study's aim of disentangling the effect of input frequency from that of uni-directional morpho-syntactic defaulting.

1.4 Previous studies of Japanese children's verb acquisition

Naturalistic studies of verb inflection in early child Japanese (e.g. Clancy, 1985; Sano, 2002; Shirai, 1993; 1998; Kato et al., 2003; Shirai & Miyata, 2006) have generally argued that acquisition is rapid, with children typically using a number of different inflections by the age of two years, and showing few errors (though with naturalistic data, it is difficult to determine the extent to which children's use of inflection is productive). The earliest forms typically include the simple past and nonpast forms, though other forms such as imperatives also appear early for some verbs.

More relevant for our purposes is a naturalistic study by Murasugi (2015) and Murasugi et al. (2010), which found that children's errors were likely to reflect the use of a past-tense form in context where this inflectional form is not appropriate. These authors concluded that the past tense form functions as a morpho-syntactic default (or "Root Infinitive analogue"). However, these findings are difficult to interpret, given that, in

[1] Although this is not directly relevant for our present purposes, verb forms can be more complex with morphological processes such as derivation, inflection and concatenation (e.g. *tabe-sase-rare-mas-i-ta* 'eat-CAUSATIVE-PASSIVE-POLITE-EPENTESIS-PAST' (someone) was forced to eat (something)). Therefore the number of possible inflectional forms of each verb is large. Indeed, many different forms (though not *all* possible forms) occur in child-directed speech. For example, the verb *tabe* 'eat' appears in 35 different inflectional forms in 305 tokens in the mother's child-directed speech sample of ArikaM in the MiiPro corpus (Nisisawa & Miyata, 2010) from CHILDES database (MacWhinney, 2000). However, because the extent to which children understand the relationship between simple and complex forms is not clear, for the purposes of the present study, we count only simple past and nonpast forms (here *tabeta* and *taberu*).

naturalistic corpora, such errors are not only rare, but difficult to identify. Grammatical features of Japanese (especially spoken Japanese), such as relatively free (pragmatically conditioned) word order, and frequent omission of both subjects and objects make it difficult for researchers to identify obligatory past and nonpast contexts.

Also relevant is a naturalistic study by Tatsumi and Pine (2016), who observed a correlation across 50 verbs between the proportion of past versus all other inflected forms in the input and in children's spontaneous speech. Importantly, this correlation was observed individually within each parent-child dyad, even after partialling out the relative frequency of past versus other forms in child-directed speech in general. This suggests that children's relative usage of different inflectional forms reflects the actual input to which they are exposed, rather than simply general properties of the target language (e.g. that both parents and children are more likely to talk about the past for some actions/verbs than others). Although this study did not investigate children's errors, its broader implication is that the relative strength of different inflectional forms in children's linguistic knowledge depends on their distribution in the input language. Another implication is that verb-specific variation in the distribution of different inflectional forms can be a powerful tool for statistically testing input-based predictions.

Together, these previous studies underline the need for a systematic and quantitative study of Japanese children's inflectional errors; an investigation which, given the shortcomings of naturalistic data studies discussed above, necessitates the use of an experimental approach. This will provide us with a uniquely strong test of the assumption of input-based accounts that children's inflectional errors reflect competition between different forms of the same verb in memory, with the accessibility or representational strength of each form related to the relative frequency of each form in the input.

1.5 The current study

The aim of the current study is to test an input-based prediction regarding the patterning of children's errors over two inflectional forms – past and nonpast – making use of a particular property of Japanese: specifically, the fact that past forms outnumber nonpast forms in the input for some verbs, with others showing the opposite pattern. The prediction is that children will make errors in both directions, using past forms in nonpast contexts, and vice versa, with the likelihood of each determined by the relative frequency of these two

forms in the input language. This type of bidirectional pattern, if observed, would be difficult to explain under an account that posits past (or, indeed, nonpast) as a default form.

Study 1

2 Method

2.1 Participants.

Twenty-two Japanese-speaking children (13 girls and 9 boys, aged between 3;2-5;8) participated in the experiment. All were monolingual speakers reported as showing no linguistic impairment. The children were recruited and tested at two nurseries in Tokyo, Japan.

2.2 Design and materials.

Twenty verbs were selected for use in the study; 10 biased towards past-tense and 10 towards nonpast tense in terms of input frequency. Frequency counts were taken from the child-directed speech (both mothers and fathers) of the ArikaM and Nanami subcorpora of the MiiPro corpus (Nishisawa & Miyata, 2009; 2010) in the CHILDES database (MacWhinney, 2000). For each verb, the token frequency of (a) the simple past form (e.g. *tabeta* 'ate') and (b) the simple nonpast form (e.g. *taberu* '(will) eat(s)') was obtained, using the FREQ function of the CLAN program (MacWhinney, 2000). Past-biased verbs and nonpast-biased verbs (see Table 18) were selected on the basis that – with one exception – the relevant bias was significantly different from chance (i.e., to 0.5 past vs nonpast) by a binomial test (p<.005 in all cases). The token frequency of verbs or verb forms was not considered in this selection process. As far as possible, the past-biased verbs and nonpast-biased verbs were matched for morpho-phonological class (vowel-ending and consonant-ending of three types of sound euphony). This required the inclusion of one past-biased verb (*fum*, 'step on'), for which the relevant bias was not significantly different from chance by a binomial test (p=.172). All verbs were chosen to be easily depicted in pictures and familiar to children.

Table 18. Test verbs for Study 1

Bias	**Verbs and meaning**	**Proportion past/ (past+ nonpast)**	***p* values from binomial test**	**Morpho-phonological class**
Past-biased	*mituke*- 'find'	0.960	1.49E-06	Vowel-ending
	ochi- 'fall'	0.860	2.06E-05	Vowel-ending
	tukamae- 'catch'	0.813	0.046	Vowel-ending
	kie- 'disappear'	1	0.002	Vowel-ending
	moraw- 'receive'	0.875	1.12E-05	Consonant-ending
	naor- 'cure'	0.848	0.000	Consonant-ending
	owar- 'end'	0.857	7.55E-06	Consonant-ending
	suk- 'become empty'	1	1.19E-07	Consonant-ending
	tuk- 'arrive'	0.8	0.021	Consonant-ending
	fum- 'step on'	0.769	0.172	Consonant-ending
Nonpast-biased	*ire*- 'put into'	0.205	2.85E-06	Vowel-ending
	ne- 'sleep'	0.128	1.93E-05	Vowel-ending
	chigaw- 'be different'	0.027	4.28E-72	Consonant-ending
	kir- 'cut'	0.192	0.000	Consonant-ending
	suwar- 'sit'	0	0.000	Consonant-ending
	tukaw- 'use'	0.111	3.08244E-06	Consonant-ending
	sagas- 'search'	0.071	0.002	Consonant-ending
	kak- 'write'	0.237	2.70E-05	Consonant-ending
	yom- 'read	0.137	1.69E-08	Consonant-ending
	asob- 'play'	0.027	1.08E-18	Consonant-ending

2.3 Procedure.

The study elicited past and nonpast verb forms for the 20 test verbs using an elicited-production sentence-completion paradigm. Children were tested individually by a native Japanese-speaking experimenter in two 10-15 minute sessions conducted on consecutive days. On Day 1, children completed a repetition task designed to introduce them to the target verb associated with each of the pictures to be shown on Day 2, and to the principle of producing each verb in both past and nonpast form. On Day 2, children completed the elicited production test, in which they produced past and nonpast verb forms in order to complete otherwise-verbless prompt sentences produced by the experimenter. The entire Day 2 session

was audio-recorded using an audio recorder. The experimenter also took note of children's responses by hand.

On Day 1, children were asked to repeat training sentences produced by the experimenter. Children were given the following instructions: 'Here is a girl called Kana-chan. She does the same things every day. I'm going to talk about her, so please repeat what I say.' For each trial, the target verb was presented twice: once in past-tense form with *kinoo* ('yesterday') and once in nonpast form with *asita* ('tomorrow'), as in the example below

Past tense sentence:

Kana-chan wa kinoo namae o kaita

Kana-chan TOPIC yesterday name ACCUSATIVE write-PAST

'Kana-chan wrote the name yesterday.'

Nonpast sentence:

Kana-chan wa asita namae o kaku

Kana-chan TOPIC tomorrow name ACCUSATIVE write-NONPAST

'Kana-chan will write the name tomorrow.'

Children repeated both sentences for each of 20 training pairs (i.e., one for each of the target verbs subsequently elicited on Day 2), while viewing a picture depicting the sentence (see Figure 1). Both the order of verbs and the order of past and nonpast sentences were randomised individually for each participant. Our goal in having children repeat each verb in both past and nonpast form was to train them on the appropriate target verb for each picture, while avoiding biasing them towards either form.

On Day 2, the experimenter introduced the elicitation test session, with the following instructions: 'Today we are going to talk about Kana-chan again. Let's just talk together.' First children completed a brief warm-up session using verbs that are different from test verbs following the same format as the test trials (see Appendix A).

For each test trial, the experimenter first introduced the target context (i.e., past or nonpast) by talking about the weather, using the same adverbs as in the training session, *kinoo* and *asita*, combined with a weather verb (e.g. Yesterday was cloudy / Tomorrow will be cloudy). This set-up sentence was designed to semantically prime either a past (yesterday) or nonpast (tomorrow) context, without using the specific verb form to be elicited from the children. Five different weather predicates were used (*kumor* 'become cloudy', *hare* 'become sunny', *ame ga fur* 'rain', *atatakaku nar* 'become warm', and *samuku nar* 'become cold'), in order to ensure that that the verb was never of the same morphological class as the target verb, hence avoiding unwanted morphological priming. During this interaction, children were shown a picture corresponding to the weather in the priming sentence (see Figure 5). Next, the experimenter produced the target sentence, omitting the verb (which, due to the verb-final word order of Japanese, is always the last word of the sentence). In this way, children were naturally prompted to produce the target verb. For this part of the process, children were shown another picture that depicted the scene of the test sentence. A complete example trial is shown in below. Each child completed 40 trials (both a past target and a nonpast target trial for each of the 20 verbs), with the exception of three participants who began, but chose not to complete the test session. The complete list of test sentences is in Appendix A.

Figure 5. Test pictures

Test trial for past form target

Experimenter: *Kinoo wa kumotta*.

yesterday TOPIC become.cloudy-PAST

Kana-chan wa kinoo namae o …

Kana-chan TOPIC yesterday name ACCUSATIVE

'Yesterday was cloudy. Kana-chan … the name yesterday'

Child: *kaita*

write-PAST

'wrote'

Test trial for nonpast form target:

Experimenter: *Asita wa kumoru*.

tomorrow TOPIC become.cloudy-NONPAST

Kana-chan wa asita namae o …

Kana-chan TOPIC tomorrow name ACCUSATIVE

'Tomorrow will be cloudy. Kana-chan … the name tomorrow'

Child: *kaku*

write-NONPAST

'will write'

2.4 Analyses.

Children's responses were dummy coded in terms of correct and error responses (correct =1 if children's response matched the target form, and error=0 if children's response

was inflected for the other tense), with all other responses excluded. These excluded responses (*N*=49) included inflected forms other than simple past and nonpast forms (e.g. *ochi-chat-ta* fall-COMPLETIVE-PAST), nouns (e.g. *keeki* 'cake') and non-target verbs. Also excluded were a further 54 trials in which children produced no response, for a final total of 777 scorable responses (103 exclusions). Predictor variables were target context (past target context=0.5, nonpast target context=-0.5), age (in months) and the proportional frequency of the target form (i.e., past/[past+nonpast] for past-target trials and nonpast/[past+nonpast] for nonpast-target trials). Note that operationalizing this variable simply as the proportion of – say – past/[past+nonpast] trials across the board would have virtually ensured an interaction between this input predictor and target context. This is because verbs with a high proportional frequency in past form are predicted to show a high rate of correct production in past-target trials, but a low rate of correct production (i.e., a high rate of error) in nonpast-target trials. This proportional frequency was considered more important as compared to other possible frequency measures such as token frequency of lemma or inflected forms, because the prediction of this study is based on the idea of probabilistic competition between two inflectional forms.

Linear mixed-effects models were fit using the lme4 package (Bates, Maechler, Bolker and Steven, 2014) of the statistical program R (R Core team, 2015). In addition to the fixed effects above, the models included random intercepts for participant and verb, and as many random slopes as possible without causing convergence failure (Barr, Levy, Scheepers & Tily, 2013). The model comparison (likelihood ratio test) method was used to determine the significance level of individual predictors (Baayen, Davidson, & Bates, 2008; Cohen-Goldberg, 2012; Barr et al, 2013), beginning with (0) a baseline model including random effects only, and adding (1) context (past/nonpast), (2) the proportional input frequency predictor and (3) the interaction between these two variables.

3 Results of Study 1

Table 19 shows the total number of valid responses and the rate of correct responses in past and nonpast tense contexts for Study 1.

Table 19. Children's responses by target context in Study 1

Target context	Total number of valid responses	Correct	Errors	Mean correct responses	SD
past	390	322	68	0.826	0.380
nonpast	387	223	164	0.576	0.495

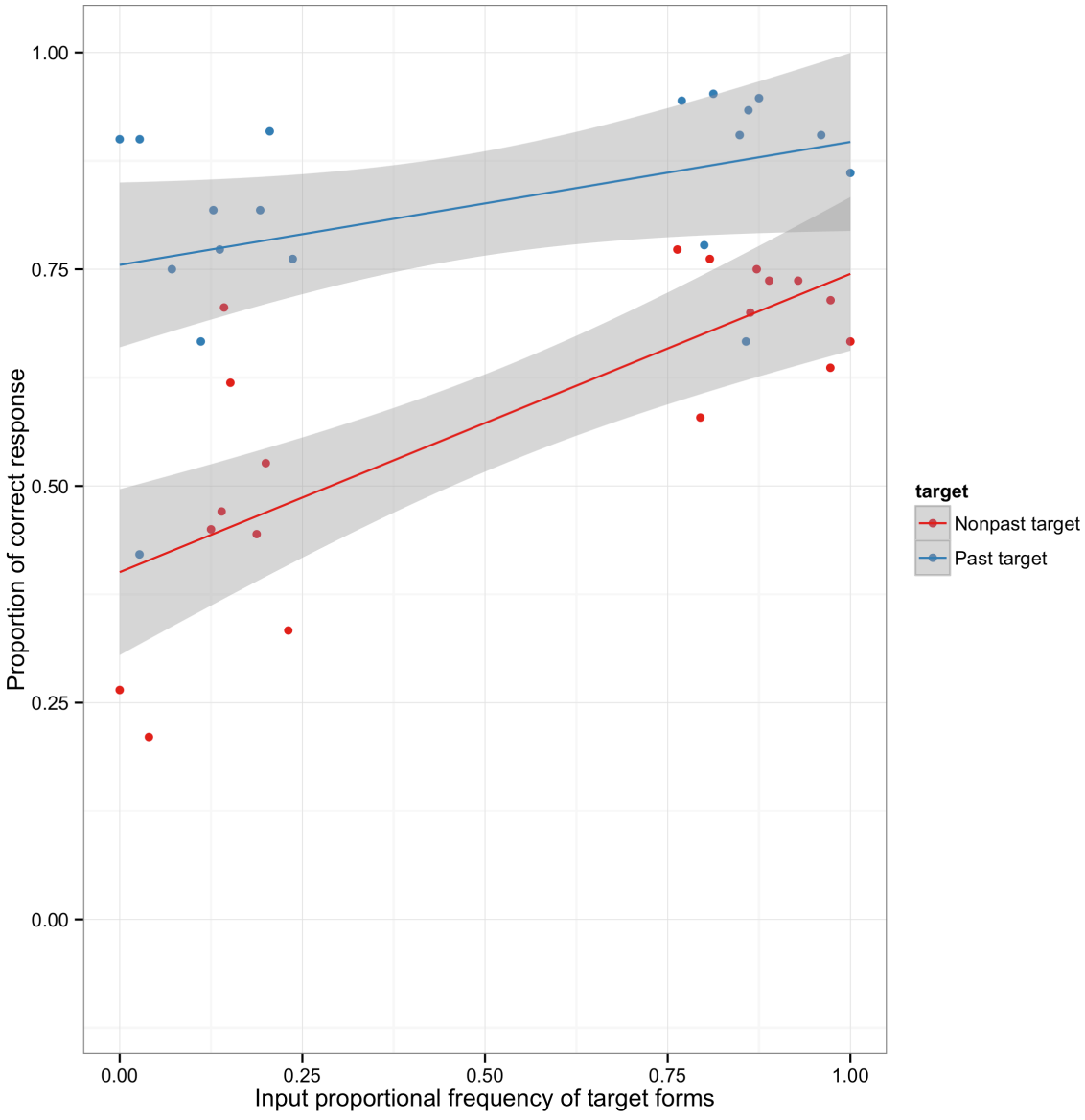
These data show that children produced similar numbers of valid responses in the two target contexts (390/440=88.6% in past and 387/440=88.0% in nonpast contexts). They also show that they were more likely to produce past tense forms in nonpast tense contexts (42%) than nonpast tense forms in past tense contexts (17%). Importantly, however, children did produce both types of error. Nor were bi-directional errors restricted to a small subgroup of children, with 14/22 making at least one error of each type. They therefore count against the idea that verb-marking errors in Japanese reflect the use of a single morpho-syntactic default form.

A mixed effects model was fitted to the children's data with target context, proportional frequency of target form in the input, and the interaction between these predictors as fixed effects (added sequentially as described above). Children's age was not included in this model because a prior model analysis revealed that this factor did not significantly predict children's response pattern (β=0.02, SE=0.02, χ^2=1.29, p=.256). The maximal model that converged had random by-item and by-subjects intercepts, and by-subject slopes for target context and for proportional frequency in the input.

This analysis revealed a significant main effect of target context (β=2.32, SE=0.88, χ^2=7.78, p=.01), such that children provided more correct responses in past target contexts (M=0.83, SE=0.38) than in nonpast target contexts (M=0.58, SE=0.49), and a significant main effect of the proportional frequency of the target form in the input in the predicted (positive) direction (β=2.17, SE=0.46 χ^2=18.02, p<.001). However, it also revealed a significant interaction between these two factors (β= -1.66, SE=0.72, χ^2=5.07, p=.02), indicating that the effect of proportional input frequency varied across past- and nonpast

target contexts. In order to interpret this interaction (see Figure 6), separate analyses were run for each target context. These analyses revealed a significant effect of input frequency for both the nonpast target context, (β=3.36, SE=0.79 χ^2=17.72, p<.001) and for the past target context (β=1.37, SE=0.63, χ^2=4.50, p=.03). The interaction therefore appeared to reflect the fact that the magnitude of this effect was larger in non-past than in past tense contexts, possibly because of a ceiling effect for past tense forms in past tense contexts.

Figure 6. Children's correct responses by relative input frequency of target forms in past and nonpast target contexts (Study 1)



4 Discussion of Study 1

The results of Study 1 provide support for the prediction that Japanese children will show a bi-directional pattern of verb-marking error, using past tense forms in nonpast tense contexts and vice versa, with the likelihood of both types of error determined by the relative frequency of these two forms in the input language. However, they also revealed an unexpected context effect, which suggests that relative frequency in the input is not the only factor determining the rate at which children make verb-marking errors. One interpretation of this effect is that it reflects a genuine advantage for past tense over non-past tense forms in Japanese, resulting from differences in the properties of past and non-past tense forms. Another is that it is a task-specific effect, which reflects the fact that some children appeared to be relatively insensitive to the context manipulation, and produced one or other of the two forms on over 75% of trials (with 9 children favouring the past tense form and 2 children favouring the non-past tense form). In order to differentiate between these two possible interpretations, we decided to conduct a second study with modifications designed to increase children's sensitivity to the context manipulation; specifically, an extended repetition and warm-up session on Day 1. We also tested younger children, with the intention of reducing any possible ceiling effect for the past-target context.

Study 2

The aim of Study 2 was to differentiate between two alternative explanations of the unexpected context effect found in Study 1, while at the same time conducting a further test of our original hypothesis that the rate at which children produced verb-marking errors would be related to the relative frequency of past and non-past tense forms in the input. This was done by modifying the procedure used in Study 1 in ways that were designed to increase children's sensitivity to the context manipulation.

5 Method

5.1 Participants.

Twenty-six Japanese-speaking children (18 girls and 8 boys, aged between 2;7-4;11) participated in the experiment. All were monolingual speakers reported as showing no linguistic impairment. The children were recruited and tested at two nurseries in Tokyo, Japan.

5.2 Design and materials.

The test verbs and sentences were the same as for Study 1. The basic procedure was also the same as for Study 1, but with two changes. First, on Day 1, children repeated both the test sentences and – unlike for Study 1 – the weather sentences. Because the weather sentences contain both a temporal adverb (*yesterday/tomorrow*) and a verb inflected for either past or nonpast (though from a different morphophonological class to the target verb), having children additionally repeat these sentences was designed to increase their sensitivity to the context manipulation in general, and to highlight the way that the target context is systematically flagged up by the weather sentence. Second, children completed a more extensive warm-up session, which included ten verbs (as opposed to just two in Study 1) each in both past and nonpast target context (see Appendix A). Unlike in Study 1, the experimenter corrected any mistakes made by the children during the warm up.

6 Results of Study 2

Table 20 shows the total number of valid responses and the rate of correct responses in past and nonpast contexts for Study 2.

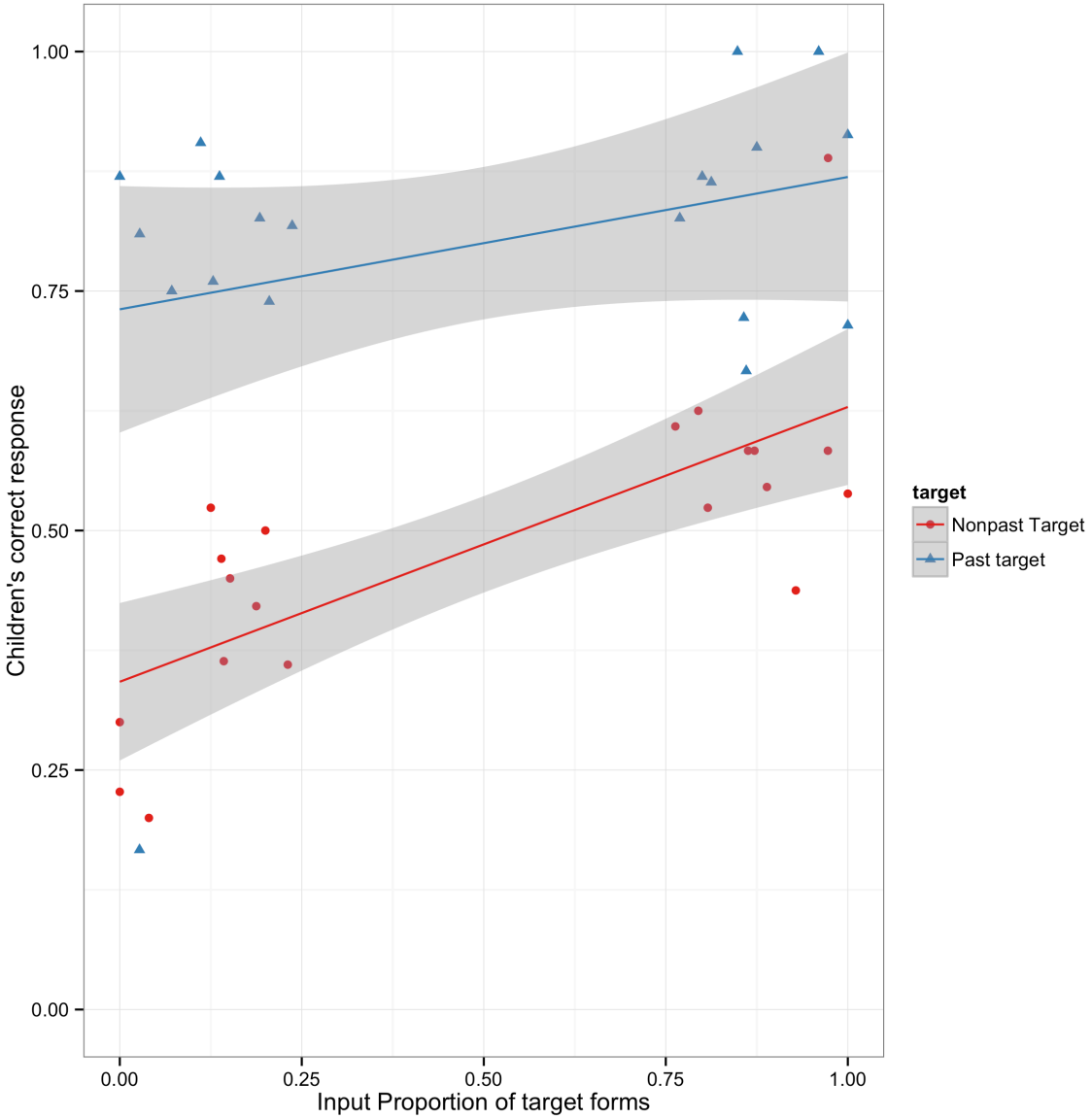
Table 20. Children's responses by target context in Study 2

Target context	Total number of valid responses	Correct	Errors	Mean correct responses	SD
past	407	330	77	0.811	0.392
nonpast	422	208	214	0.493	0.501

These data show that children produced similar numbers of valid responses in the two target contexts (407/520=78.3% in past and 422/520=81.2% in nonpast contexts). They also show that children made errors in both directions (with the vast majority of children (23/26) making at least one error of each type). However, as in Study 1, children were considerably more likely to produce past tense forms in nonpast contexts (51%) than nonpast forms in past tense contexts (19%).

A mixed effects model was fitted to children's data with target context, proportional frequency of the target form in the input, and the interaction between these predictors as fixed effects (added sequentially, as for Study 1). Again, children's age was not included because it was not significant in a preliminary analysis (β=0.02, SE=0.02, χ^2=1.15, *p*=.282). Following the maximal model method (Barr et al. 2013), the final model had random by-item and by-subjects intercepts as well as by-subject slope for target contexts. The model revealed a significant main effect of target context (β=2.10, SE=0.69, χ^2=7.23, *p*=.01), such that children provided more correct responses in past target contexts (M=0.81, SE=0.39) than nonpast target contexts (M=0.49 , SE=0.50). The model also revealed a significant main effect of input proportional frequency of target form, in the predicted (positive) direction (β=1.78, SE=0.29, χ^2=44.71, *p*<.001). However, unlike for Study 1, the interaction between these factors (see Figure 7) did not reach significance (β= -0.04, SE=0.60, χ^2=0, *p*=1).

Figure 7. Children's correct responses by relative input frequency of target forms in past and nonpast target contexts (Study2)



7 Discussion of Study 2

The results of Study 2 provide further support for the prediction that Japanese children will show a bi-directional pattern of verb-marking error, which is conditioned by the relative frequency of past and non-past tense forms in the input language. However, they also suggest that there is a general advantage for past tense over non-past tense forms in Japanese children's speech. At first glance, this last finding might seem to be consistent with the claim that in Japanese, the past-tense form functions as a morpho-syntactic default (e.g. Murasugi, 2015; Murasugi, et al. 2010). In fact, however, such an account cannot explain either the bi-directional pattern of error or the effects of input frequency found in our data. One possible

alternative explanation (discussed in more detail below) is that this general advantage reflects the greater phonological regularity of past tense versus non-past tense forms in Japanese.

8 General discussion

The aim of the present study was to test the claim of input-based accounts of language acquisition that children's inflectional errors reflect competition between different forms of the same verb in memory, with the accessibility or representational strength of each form related to the relative frequency of that form in the input. In order to distinguish this possibility from the alternative possibility that errors reflect the use of a morpho-syntactic default form, we focused on the Japanese verb system, in which past forms outnumber nonpast forms in the input for some verbs, with others showing the opposite pattern.

Our results provide support for an input-based account in two ways. First, they reveal a bi-directional pattern of verb-marking error in which children produce past tense forms in non-past tense contexts and non-past tense forms in past tense contexts. This bi-directional pattern is very difficult to explain in terms of the use of a morpho-syntactic default. Second, they show that the likelihood of making both types of error is related to the relative frequency with which past and non-past tense forms of the verb occur in the input language. This finding provides direct support for the idea that children's inflectional errors reflect competition between different forms of the same verb in memory.

A very similar pattern of results was found across two different elicited production studies. However, both of these studies also revealed a significant advantage for past tense over non-past tense forms. Since this advantage is probabilistic rather than uni-directional, it cannot be explained in terms of the use of a morpho-syntactic default. However, it does suggest that frequency-based competition is not the only determinant of the pattern of verb-marking error in children's speech. One factor that might explain the general advantage for past tense forms in our data is the greater phonological regularity of past tense versus nonpast tense forms in Japanese. Thus, for Japanese past tense forms, the final mora is always *–ta* or *–da*, whereas for non-past tense forms, the final mora consists of the final segment of the verb plus *–(r)u*, which means that non-past tense forms can end in a wider range of different moras. This may make it easier to generate past tense than non-past tense forms, and hence result in a probabilistic advantage for past tense forms. At the same time, including other frequency measures, such as token frequency of inflected forms or that of morphophonological pattern, into the analysis can be another way to understand the unexpected pattern in the results.

This explanation is inevitably somewhat speculative, and whether it is correct or not is obviously a question for future research. Whatever the case, it is clear that the results of the present study do provide strong support for the idea that the patterning of children's verb-marking errors is determined at least in part by frequency-sensitive competition between past and nonpast forms of the same verb in memory. As we noted in the introduction, the results of previous studies that have reported such effects (e.g. Räsänen, et al. 2014; Aguado-Orea & Pine, 2015) are not definitive because they rely on the consistent production of one form in place of another (bare/infinitive form for 3sg *–s* in English; 3sg for 3pl in Spanish), and hence are also consistent with accounts based on morpho-syntactic defaulting. Focusing on Japanese verbs, which show a verb-specific, bi-directional probabilistic patterning, has allowed us to overcome this difficulty, and to differentiate between input-based and defaulting hypotheses. The wider implication is that studying languages with different statistical patterns of usage to the Indo-European languages that are more typically studied may be a useful way of distinguishing between theories that, for many languages, make similar predictions. Future cross-linguistic research into children's use of verb inflection should take into account factors other than input frequency, such as morphological and phonological complexity and regularity. In the meantime, the findings of the present study constitute perhaps the most direct evidence to date that children's inflectional errors reflect not morpho-syntactic defaulting but competition between different forms of the same verb in memory, with the accessibility or representational strength of each form related to the relative frequency of each form in the input.

Chapter 7: Disentangling effects of input frequency and morpho-phonological complexity on children's acquisition of verb inflection: an elicited production study of Japanese

Rationale for the study in Chapter 7

The study reported in Chapter 7 extends the investigation of input-driven learning mechanisms to a broader range of inflections, namely morphologically simple and complex inflections. All the studies reported in Chapters 4 to 6 have shown effects of input frequency on children's production of inflections and thus provided support for the constructivist view. At the same time, though, this view also assumes that the acquisition process is a complex process in which different factors interact to influence developmental changes in children's knowledge. The study reported in Chapter 7 aims to study the effect of input frequency while controlling for an important confounding factor: morpho-phonological complexity. The key research question in this study is whether input frequency is a significant factor in children's production of verb inflections over and above morpho-phonological complexity.

Morpho-phonological complexity is an important factor that has been assumed to influence acquisition (e.g. Aguado-Orea & Pine, 2015), but effects of input frequency and morpho-phonological complexity are difficult to disentangle because complex forms tend to be less frequent than simple forms. Although the literature documents effects of both of these factors, the fact that they are actually confounded has not been sufficiently addressed (e.g. Otomo et al., 2015). This study looks for a real effect of input frequency by controlling for morphophonological complexity.

The design of the study again makes use of by-verb variation in the distribution of inflections in Japanese. Some morphologically complex forms are more frequent than simple forms, depending on the verb. This variation in the frequency distribution of different verbs is the key to sampling different production patterns across verbs. The method is very similar to the method used in in Chapter 6. Sentence-completion experiments elicited children's production of simple and complex inflectional forms for verbs that were selected on the basis of their frequency distribution in the input. The inflections studied were morphologically simple and complex; simple past and stative past inflections in Study 1 and simple past and completive past inflections in Study 2. The rate at which children produced these simple and complex forms is analysed in terms of the relative frequency of these forms in the input to

test the constructivist prediction that children's use of complex forms will be influenced by the frequency with which those verbs occur as complex versus simple forms in the input.

1. Introduction

Input frequency has been shown to be a key factor in explaining the pattern of children's language development. Indeed, it is almost certainly the factor that has received the greatest degree of empirical attention and support. Effects of input frequency have been observed in many different domains including phonology, vocabulary, simple and complex syntax, and – the focus of the present article – inflectional morphology (see Ellis, 2002, and Ambridge et al., 2015, for reviews). However, this factor is confounded with various other factors (e.g. Lieven, 2010; Tomasello & Stahl, 2004), most notably, at least in the domain of inflectional morphology, morpho-phonological complexity. Whether one is counting phonemes, morphemes, syllables or objective duration, high frequency forms (e.g. *walk*) tend to be shorter and simpler than lower frequency equivalents (e.g. *walks, walking, ambulates*). Thus, virtually all previous findings of (apparent) frequency effects at the level of inflectional morphology could, in principle, be effects of morpho-phonological complexity in disguise. The goal of this study is to disentangle these two factors, by focusing on Japanese; a language whose system of agglutinative morphology allows for frequency and complexity to be dissociated at the level of individual verb stems.

1.1 Effects of frequency in child language

Input-based accounts of language acquisition claim that patterns in children's usage and error reflect distributional properties of the input language. Although input-based accounts have been proposed from a variety of theoretical perspectives (see Ambridge et al, 2015, for a review), they sit most naturally with the constructivist view, under which children build their linguistic knowledge on the basis of their experience with language, and hence are predicted to show frequency effects at all levels (e.g. Bybee, 2006; Ellis, 2002; Tomasello, 2003). Indeed, many studies have found a relationship between children's use of linguistic forms and the frequency with which these forms occur in the input language (e.g. Goodman, Dale & Li, 2008; Smiley & Huttenlocher, 1995; Naigles & Hoff-Ginsberg, 1998; Theakson, Lieven, Pine & Rowland, 2002; 2004; Zamuner, Gerken, & Hammond, 2005).

The domain of inflectional morphology is particularly well suited to the investigation of frequency effects, because it is possible to look for relative frequency effects at the levels of individual verb (or noun) stems. It is generally agreed that because, in this domain, frequency effects arise as a result of probabilistic competition between semantically very similar forms (e.g. *play* vs *plays*) it is the *relative* rather than *absolute* frequency of each

form (most simply captured as a simple proportion or ratio) that is the appropriate input-frequency measure (see Ambridge et al, 2015: 247 for discussion). For example, Räsänen et al. (2014) investigated children's errors of using bare/nonfinite forms instead of finite forms in English (e.g. **He play* for *He plays*), and found that the by-verb error rate in an elicited production study was explained by the proportional frequency of these verbs in bare versus 3sg *-s* forms in child-directed speech. For example, *fit* occurred relatively often in 3sg form in Räsänen et al.'s input sample, and was never produced incorrectly in the experiment, whereas *find* never occurred in 3sg form in the input sample and was produced incorrectly 50% of the time. Similarly, in a study of zero-marking errors for English noun plural marking, Matthews and Theakston (2006) found an effect of relative input frequency such that, for example, children often produced errors such as **two mouse* (for *two mice*) but rarely produced errors such as **two tooth* (for *two teeth*), because the ratio of *mouse:mice* (roughly 7:1) is much greater than the ratio of *tooth:teeth* (roughly 1:6).

Importantly, particularly with regard to the present study, effects of proportional input frequency are observed not only for error rates, but also for patterns of (correct) usage. For instance, Tatsumi and Pine (2016) showed that, in Japanese, the proportional frequency of past-inflected forms varies greatly across verbs in a child-directed speech sample, and that this frequency measure predicted children's usage of the inflection. Specifically, the proportional frequency of past tense forms versus all other inflectional forms in each child's data correlated highly with that in his/her caregivers' child-directed speech. Moreover, this result held even after controlling for the general semantic-distributional properties of Japanese child-directed speech by partialling out the proportional frequency of past tense forms averaged across the speech of the other caregivers in the sample.

1.2 Frequency and morpho-phonological complexity in verb inflection

On the face of it, the fact that by-verb variation in the proportional frequency of different inflectional forms predicts both children's error rates and patterns of correct usage would seem to constitute powerful support for an account under which linguistic knowledge builds up as a result of input-based learning. On closer inspection, however, this evidence is less than compelling because, in many of these cases, frequency is confounded with morpho-phonological complexity. This point is perhaps most clearly illustrated by studies of children's 'defaulting' errors; so called because children are claimed to default to a particular form in the inflectional paradigm when they have difficulty retrieving the target form. For

example, in a dense corpus study, Aguado-Orea and Pine (2015) found that the majority of verb-agreement errors produced by two Spanish-speaking children involved the use of 3rd person singular (3sg) forms in non 3rd person singular contexts (e.g. **Tú* [2sg] *come* [3sg], for *Tú* [2sg] *comes* [2sg]. 'you eat'). While Aguado-Orea and Pine (2015) characterised these errors in terms of children's defaulting to the form of each verb with the highest input frequency (i.e., 3sg), at least two other defaulting-based explanations are possible. First, 3sg could constitute a morpho-syntactic default; a form that can be used even when its agreement features (third person, singular) are not licensed by the subject (e.g. Radford & Ploennig-Pacheco, 1995). Second, as Aguado-Orea and Pine (2015) themselves note, Spanish 3sg forms are not only the most frequent, but also the most phonologically prototypical and simple forms in the paradigm (e.g. *come* vs *com**es/emos/éis/en***), whether measured in phonemes, morphemes or objective duration. (In the present article, we abstract away from the question of how complexity is best measured, and use "morpho-phonologically complex" as a catch-all term for forms that are longer on all three of these dimensions). Indeed, as the example of **come* for *com**es*** shows, the form to which children are defaulting is often – phonologically speaking – the target form with one or more phonemes omitted.

A similar situation holds for Finnish-speaking children's person-number agreement errors. Children sometimes misuse both the 3sg form (as in Spanish) and the 2sg imperative form in contexts in which these forms are ungrammatical (Räsänen et al., 2015). Again, these forms are not only highly frequent forms but also morpho-phonologically simple forms. For example, the 2sg imperative form bears no overt morphological marking, and is phonologically indistinguishable from the stem form (Laalo, 2003).

Consequently, it is not possible, for any of these previous studies, to determine whether apparent frequency effects are in fact caused by a confound with morpho-phonological complexity, underlining the need to distinguish these often-confounded factors. One possible way to do so is to consider languages that show by-verb variation in the frequency of morpho-phonologically simple and complex forms, such that the more complex form is less frequent than the corresponding simple form for some verbs, but *more* frequent than the corresponding simple form for others. The present study focusses on Japanese, which has this property for (at least) two classes of complex form: statives (Study 1) and completives (Study 2).

1.3 Morphological characteristics of Japanese verb inflection

Japanese has a relatively rich system of verb inflection in which a number of distinctions, including tense, aspect, voice, polarity and politeness are expressed by means of suffixation on verb stems. It is worth emphasizing that the notion of inflection in Japanese is different from 'Latin-type' fusional inflection. As Shibatani (1990: 221) describes, inflectional endings "are fairly clearly segmentable, and the segmented endings (or suffixes) are correlated with inflectional categories in a one-to-one fashion". The simplest verb form consists of a verb stem with a tense-marking suffix (non-past or past), as in *tabe-ru* 'eat-NONPAST' and *tabe-ta* 'eat-PAST'. Because Japanese verb morphology is agglutinative, more suffixes can be attached to these simple forms, in each case between the stem and the tense-marking suffix. In the present article, we focus on two aspectual suffixes: the stative and the completive marker.

The stative inflection[2] is marked with the suffix *-te*, as in *tabe-te-ru* (eat-STATIVE-NONPAST), 'be eating' and *tabe-te-ta* (eat-STATIVE-PAST), 'was/were eating'. The meaning of this aspectual marker is usually described as stative or progressive (this paper uses the label 'stative' for convenience), depending on the meaning of the verb. A stative interpretation is most natural when this suffix is combined with verbs that have the semantic feature of completion or achievement such as *tuk-* 'arrive', as in *tui-te-ru* 'be arrived' (i.e., to be present). A progressive interpretation is most natural when this suffix is combined with action verbs, as for the above example of *tabe-te-ta*, 'was/were eating' (e.g. *I was eating, when suddenly the phone rang*).

The completive inflection[3] is marked with the suffix *–chaw* (which changes to *–chat* when followed by the PAST marker*)*, as in *tabe-chat-ta* (eat-COMPLETIVE-PAST), 'ended up eating' or 'has/have eaten'). Semantically, this marker denotes completed aspect, often with an unexpected or negative implication (e.g. *I'd already had lunch but my friend persuaded me to meet her in a café, and I* ***ended up eating*** *again*).

In terms of frequency of use, although complex forms generally outnumber simple forms in terms of types (i.e., different inflectional forms of the same verb stem),

[2] The stative form diachronically is a reduced form from the combination of connective *-te* and subsidiary verb *i-* 'be, exist' (Kudo, 1995). Therefore *tabe-te-ta* is reduced from a compound verb construction *tabe-te i-ta*, and the reduced form is common in spoken Japanese.

[3] The completive form is also a reduced form, and the non-reduced construction consists of connective *-te* and a subsidiary verb *shimaw-* 'end'. The reduced form is very common in spoken language.

simple forms are generally more frequent in terms of tokens (in line with a language-general distributional pattern; e.g. Anglin, Miller, & Wakefield, 1993). For example, in child-directed speech from the MiiPro corpus (Nishisawa & Miyata, 2009; 2010; from the CHILDES database, MacWhinney, 2000), *tabe-*, 'eat' occurs in 50 different complex forms (those which have two or more inflectional morphemes attached to the stem), and 17 different simple forms (those which have a mono-morphemic ending). Nevertheless, in terms of tokens, simple forms (656) outnumber complex forms (418 tokens). However, despite this general pattern, for some verbs, certain complex forms (including the stative and completive forms investigated in the present study) outnumber their corresponding simple forms. It is this rather unusual feature of Japanese that makes it ideal for dissociating the roles of token frequency and morpho-phonological complexity.

1.4 Previous studies of frequency and morpho-phonological complexity in Japanese

The findings of a number of previous studies of Japanese verb inflection suggest that both (a) high input frequency and (b) morphological simplicity aid acquisition (to our knowledge, none have attempted to dissociate these factors). But at the same time, some studies have found that certain complex forms appear early and/or are used often by children.

Differences in the emergence and usage of inflected verb forms have been explained in terms of input frequency in many studies (e.g. Otomo et al., 2015; Shirai, 1993). For example, as noted above, Tatsumi and Pine (2015) studied the distribution of inflectional forms in a naturalistic speech sample and demonstrated that children's usage of different inflectional forms of the same verb (e.g. *tabe-ta* 'eat-PAST' vs *tabe-ru* 'eat-NONPAST') correlates highly with that of their caregivers. In a follow-up elicitation study, Tatsumi, Pine and Ambridge (submitted) investigated the effect of input frequency in children's misuse of past-tense forms in nonpast contexts and vice versa (e.g. *tabe-ta* 'eat-PAST', describing an action that is planned to take place *asita*, 'tomorrow'). The findings showed that children's error rate is explained by the by-verb frequency distribution of these two tense forms in a sample of child-directed speech. For example, children were most likely to use a past-tense form in a nonpast context for a past-biased verb such as *mituke* 'find' for which the proportional frequency of past versus nonpast forms in the dataset was 0.96. Conversely, children were more likely to use a nonpast-tense form in a past context for a nonpast-biased verb such as *tukaw* 'use', for which the proportional frequency of past versus nonpast forms was 0.11.

A higher degree of morpho-phonological complexity is generally considered to negatively affect learning. Many corpus-based studies of verb inflection in child Japanese report that most of children's earliest forms are morphologically simple (e.g. Clancy, 1985; Otomo et al., 2015; Shirai, 1993; 1998; Shirai & Miyata, 2006). On the basis of these and similar observations, Takanashi (2009) proposed a learning process whereby children generally proceed from simple forms to complex forms by the addition of morphemes.

At the same time, however, some of these corpus studies show that certain complex forms are observed even in the very early stages, and suggest that input frequency might be a particularly important factor for these complex forms (e.g. Clancy, 1985; Otomo et al., 2015). For example, Iwatate (1981), in a study on the emergence of verb inflection, observed the production of complex forms like *tabechatta* eat-COMPLETIVE-PAST 'ended up eating' in the earliest observable stage (e.g. at 2;1), and argues that children do not always start with morphologically simple forms.

Together, these previous studies suggest that both input frequency and morpho-phonological complexity are important factors in the acquisition of Japanese inflection, further highlighting the need for a study designed to pull apart these often-confounded factors.

1.5 The present study

In summary, many previous studies of inflectional morphology (including studies of English, Finnish, Spanish and Japanese) have observed apparent effects of input frequency. However, since frequency is negatively correlated with morpho-phonological complexity, it remains possible that many apparent frequency effects are in fact complexity effects in disguise. The aim of the present study is therefore to dissociate these factors by focusing on Japanese; a language that shows by-verb variation in the frequency of simple and complex forms, such that the more complex form is less frequent that the corresponding simple form for some verbs, but *more* frequent than the corresponding simple form for others. Specifically, we predict a positive correlation across verbs between the ratio of complex: simple forms in a representative input corpus and children's experimental production data. The two pairs of complex and simple forms are (**Study 1**) stative past (e.g. *tabe-te-ta,* EAT-STATIVE-PAST, 'was eating') versus simple past (e.g. *tabe-ta,* EAT-PAST, 'ate') and (**Study 2**) completive past (e.g. *tabe-chat-ta*, EAT-COMPLETIVE-PAST, 'have eaten', 'ended up eating') versus simple past (e.g. *tabe-ta,* EAT-PAST, 'ate'). Thus, we predict that the proportion of stative vs simple forms produced by children in Study 1 will be higher for verbs like *wasure* 'forget',

for which stative past forms outnumber simple past forms (17 tokens vs 7 tokens in the child-directed speech sample mentioned above) than verbs like *fum* 'step on', for which stative past forms are less frequent than simple past forms (2 tokens vs 13 tokens). Similarly, we predict that the proportion of completive vs simple forms produced by children in Study 2 will be higher for verbs like *wasure* 'forget', for which completive past forms outnumber simple past forms (24 tokens vs 5 tokens) than verbs like *mituke* 'find', for which completive past forms are less frequent than simple past forms (2 tokens vs 14 tokens).

The reason for choosing these particular inflectional forms is that both statives and completives are relatively frequent in child (and child-directed) speech. Importantly, because, in both cases, the difference in meaning between the complex and simple forms is mainly aspectual, it is straightforward to devise experimental settings in which the use of either form is natural.

Study 1: Simple past vs complex stative past

2 Method

2.1 Participants

Twenty-eight children (19 boys and 9 girls) aged 3;3-4;3 (mean=3;10), recruited from nurseries in Tokyo, participated in the experiment. All were native monolingual speakers of Japanese reported as showing no linguistic impairment.

2.2 Design and materials

Twenty verbs were selected for use in the target pictures to be described by children: 10 biased towards simple past and 10 towards stative past forms in terms of input frequency. Frequency counts were taken from all combined child-directed speech (both mothers and fathers) in the MiiPro corpus (Nishisawa & Miyata, 2009; 2010) in the CHILDES database (MacWhinney, 2000). For each verb, the token frequency of (a) the simple past form (e.g. *arat-ta* 'washed') and (b) the stative past form (e.g. *arat-te-ta,* 'was washing') was obtained, using the FREQ function of the CLAN program (MacWhinney, 2000). In general, simple-past-biased and stative-past-biased verbs (see Table 21) were selected on the basis that the relevant bias was significantly different from chance (i.e., from 50/50) by binomial test (p<.05). However, in order to obtain a sufficient number of verbs (bearing in mind their suitability for illustration in still pictures and familiarity to children), we also included 5 stative-biased verbs and 2 simple-biased verbs for which this bias did not reach significance.

In addition to these 20 target verbs for use by children, 20 unbiased verbs (by binomial test) were selected for use by the experimenter (see Table 21).

A potential problem is that because simple past forms outnumber stative past forms (in this dataset by 7,545 to 791), a straightforward ratio measure does not represent the true extent of a particular verb's bias towards simple or stative past. That is, a bias of (for example) 4:1 in favour of stative-biased verbs is typically based on just a handful of uses, while a bias of 4:1 in favour of simple-biased verbs is typically based on tens of uses (in two cases > 100). To address this problem, as outlined in more detail below, we used a chi-square statistic as a measure of verb bias[4]. Note that this is a way to better understand and represent the distributional characteristics of target forms in the language, and does not necessarily assume that children have some knowledge of general frequency distribution of inflections.

Table 21. Target verbs for use by children

					summed input frequency four MOTs		
	verb	meaning	morphological class	bias	Frequency (simple past)	Frequency (stative past)	Binomial test
C1	araw	wash	Consonant	simple	23	1	<.001
C2	fum	step on	Consonant	simple	13	2	<.001
C3	hair	enter	Consonant	simple	173	57	<.001
C4	hippar	pull	Consonant	simple	11	1	<.001
C5	taore	fall_down	Vowel	simple	11	2	0.002
C6	nor	ride	Consonant	simple	85	17	<.001
C7	tukamae	catch	Vowel	simple	26	1	<.001

[4] In fact, the same pattern of significant results was found in both studies when proportional frequency was used as the input predictor.

C8	mawar	turn	Consonant	simple	6	3	0.090
C9	nak	cry	Consonant	simple	28	15	0.016
C10	nom	drink	Consonant	simple	10	5	0.059
C11	wasure	forget	Vowel	stative	7.0	17.0	0.011
C12	sir	know	Consonant	stative	0.0	23.0	<.001
C13	mot	hold	Consonant	stative	11.0	13.0	0.271
C14	mat	wait	Consonant	stative	4.0	6.0	0.172
C15	hasir	run	Consonant	stative	0.0	3.0	<.001
C16	nokor	remain	Consonant	stative	2.0	4.0	0.109
C17	kabur	put_on_hat	Consonant	stative	1.0	4.0	0.031
C18	hak	wear	Consonant	stative	1.0	4.0	0.031
C19	waraw	laugh	Consonant	stative	1.0	3.0	0.063
C20	kakure	hide	Vowel	stative	1.0	3.0	0.063

Verbs for experimenter

					summed input frequency four MOTs		
	verb	meaning	mor class	bias	freq (simple)	freq (stative)	Binomial test
E1	hik	play	Consonant	unbiased	1.0	0.0	0.5
E2	sagas	look for	Consonant	unbiased	3.0	2.0	0.5
E3	odor	dance	Consonant	unbiased	1.0	0.0	0.5
E4	oyog	swim	Consonant	unbiased	2.0	0.0	0.25
E5	oki	get up	Vowel	unbiased	2.0	2.0	0.688
E6	asob	play	Consonant	unbiased	13.0	16.0	0.77
E7	narab	line up	Consonant	unbiased	0.0	1.0	1

E8	ur	sell	Consonant	unbiased	2.0	1.0	0.5
E9	tukam	grab	Consonant	unbiased	0.0	1.0	n.a
E10	shaber	chat	Consonant	unbiased	1	2.0	0.875
E11	osie	teach	Vowel	unbiased	3.0	4.0	0.773
E12	Kuttuke	stick	Vowel	unbiased	1.0	1.0	0.75
E13	aruk	walk	Consonant	unbiased	5.0	2.0	0.227
E14	fur	rainfall	Consonant	unbiased	3.0	2.0	0.5
E15	hos	dry	Consonant	unbiased	1.0	2.0	0.875
E16	mak	wind	Consonant	unbiased	0.0	2.0	n.a
E17	magar	bend	Consonant	unbiased	2.0	1.0	0.5
E18	yorokob	be pleased	Consonant	unbiased	3.0	2.0	0.5
E19	sak	bloom	Consonant	unbiased	2.0	1.0	0.5
E20	ker	kick	Consonant	unbiased	3.0	1.0	0.313

2.3 Procedure

Children were tested individually in a classroom or teachers' room. Each child completed a test session of approximately 10 minutes, together with a native Japanese-speaking experimenter, in front of a laptop computer (Macbook Pro, 11 inch). Before the session, the experimenter told each child that they would play a bingo game together in which they would take turns to describe pictures, in order to win star cards to fill up a grid, with the first to fill all six squares declared the winner (e.g. Rowland et al., 2012). The experiment was presented using Processing (https://processing.org/).

For each trial, the computer presented a still picture depicting a scene, and an audio stimulus of the corresponding verb in a simple non-past form (described to children as the "clue word"). The player (either the experimenter or the child) then described the picture. The experimenter, who always went first, always described the pictures using stative past forms in order to prime these forms for children (though simple past forms are also perfectly acceptable in this context). This priming was necessary in order to encourage children to use

both stative and simple past forms. With no such priming children would have been likely to use exclusively simple past forms. For the child's turn, the experimenter, following the clue word, provided the target sentence except for the verb (always the final element of the sentence), to be supplied by the child. In order to highlight the past-tense context (in which both stative past and simple past forms are totally acceptable), all sentences began with the temporal adverb *kinoo,* 'yesterday'. The following example shows a set of experimenter and child turns. The complete list of test sentences is in Appendix B.

Experimenter's turn

Computer: *Hiku* (while showing a picture of a girl playing the guitar)

play-NON.PAST

'play'

Experimenter: *Kinoo Yuuchan wa gitaa o hii-te-ta.*

yesterday Yuuchan TOPIC guitar ACC play-STATIVE-PAST

'Yesterday Yuuchan was playing the guitar'

Child's turn

Computer: *Arau* (while showing a picture of a girl washing her hands)

wash-NON.PAST

'wash'

Experimenter: *Kinoo Yuuchan wa te o ...*

yesterday Yuuchan TOPIC hand ACC

'Yesterday Yuuchan ... her hands'

Child: *Arat-te-ta / Arat-ta*

wash-STATIVE-PAST/ wash-PAST

'was washing/ washed'

After each trial, the computer displayed a star or a cloud to indicate whether or not the player received a star card. This was independent of the response given, and followed a pre-determined sequence that ensured that the child won each game. Although receiving a star or cloud might have influenced children's following response, this is not a problem for the results as the trials were randomised. Each session consisted of two games, each consisting of 20 trials (10 turns for each player), such that every child completed a target trial for every verb. Children's responses were recorded using Audacity (http://www.audacityteam.org/) and a separate audio recorder for later transcription and coding (by the first author).

2.4 Analyses

Children's responses were analysed on a trial-by-trial basis, using mixed effects models in R, coded as 1 if the target verb was used in (complex) stative past form and 0 in simple past form, with all other responses excluded (*N*=166). These excluded responses, were 89 simple non-past forms (reflecting use of the clue words), 10 in some other inflectional form such as stative non-past forms, 34 responses using non-target verbs, and 33 responses of other types such as nouns and adjectives (e.g. *hen* 'strange'). The number of unscorable responses is not unexpected given the experimental design, in which children are free to produce any response, with no direct instructions (e.g. completive past form; *nai-chat-ta* 'ended up crying'), and is similar to that observed in comparable studies (e.g. Räsänen et al., 2014). Also excluded were a further 12 trials for which children produced no response and 1 trial for which the experimenter failed to provide the correct prime sentence, for a final total of 381 scorable responses.

Predictor variables were trial number (for investigating the possibility of incremental priming throughout each experimental session, given that the experimenter always produced stative past forms) and input bias (stative vs simple past). In order to take into account the overall preponderance of simple past forms, this predictor was a chi-square value (without Yates' correction) calculated from counts taken from the MiiPro corpus; Nisisawa & Miyata, 2010). This value (see the following formula and Table 22) represents the extent to which a verb's particular bias towards stative vs simple past forms (or vice-versa) differs from the bias shown by all other verbs in the corpus. Because the chi-square test is non directional, we set the sign to positive if the ratio of stative:simple past forms was greater for the target verb than for all other verbs, and otherwise to negative. The use of polarity (+/-) to indicate whether a verb is biased towards or against a particular morpheme or (more usually)

construction is standard for this type of analysis (see, e.g. Gries, 2015, for discussion). Chi-square values were natural-log transformed (ln(1+*n*)) prior to any polarity change.

$$\chi^2 = (ad-bc)^2*(a+b+c+d)/(a+c)(c+d)(b+d)(a+b)$$

Table 22. Contingency table for the calculation of chi-squares

	Target verb	All other verbs	Row totals
Stative past form	a	b	a+b
Simple past form	c	d	c+d
Column totals	a+c	b+d	a+b+c+d

Linear mixed-effects models were fit using the lme4 package (Bates et al., 2014) of the statistical program R (R Core team, 2015). In addition to the fixed effects above, the models included random intercepts for participant and verb, and as many random slopes as possible without causing convergence failure (Barr et al., 2013). The model comparison (likelihood ratio test) method was used to determine the significance level of individual predictors (Baayen et al., 2008; Cohen-Goldberg, 2012; Barr et al., 2013). This method involves sequentially adding predictors – here (1) trial number, (2) the chi-square input-bias predictor and (3) the interaction – to an initial baseline model that includes random effects only, and comparing each pair of models by means of a chi-square test (using the anova function of R).

3 Results (Study 1)

Table 23 shows the total number of valid responses and the rate of responses in stative past (complex) for verbs with different biases for Study 1.

Table 23. Children's responses by verb bias in Study 1

Verb bias	Total number of valid responses	Response in simple past	Response in stative past	Mean responses in stative past	SD
simple past	210	77	133	0.633	0.483
stative past	171	56	115	0.673	0.471

A binomial mixed effect model was fitted to children's responses (stative/simple past forms) with predictor variables of trial number (see Figure 8) and stative-vs-simple input bias (chi-square measure; see Figure 9), and the interaction. The final model that converged had by-subject and by-item intercepts, and a by-subject slope for input bias. The model comparison procedure revealed no significant effect of trial number (β=-0.001, SE= 0.02, χ^2= 0.17, p=0.68), indicating that priming did not build up over the course of the study (see Figure 8). Nor did the addition of input bias (β=0.36, SE=0.29, χ^2=1.58, p=0.21) (see Figure 9) or the interaction (β=0.02, SE=0.01, χ^2=3.02, p=0.08) significantly improve the model[5].

[5] To the extent that the non-significant interaction is interpretable, the positive sign suggests that the effect of input bias – though itself non-significant – showed a tendency to increase slightly over the course of the experiment.

Figure 8. Proportion of children's stative vs simple past forms by trial number

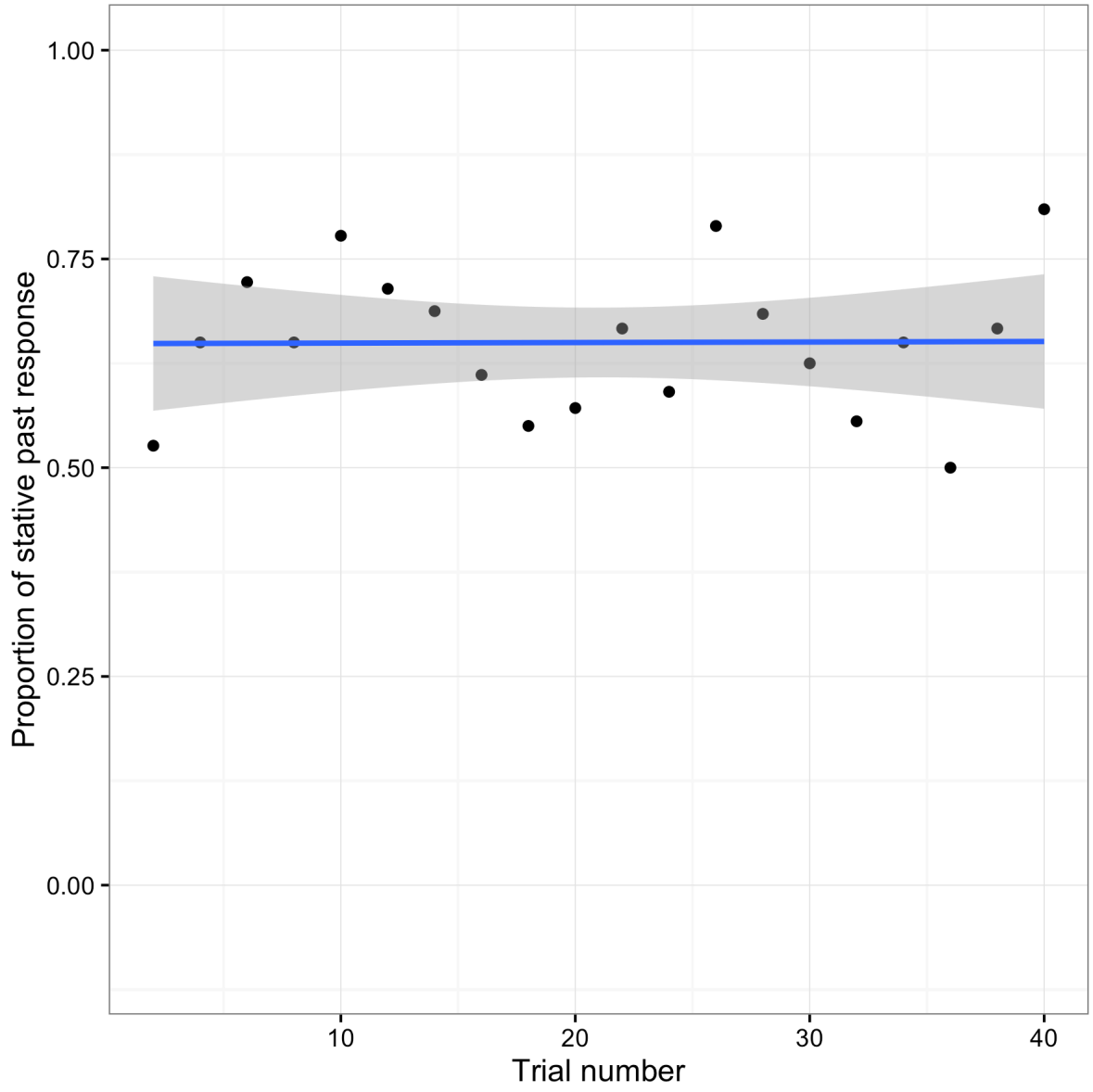
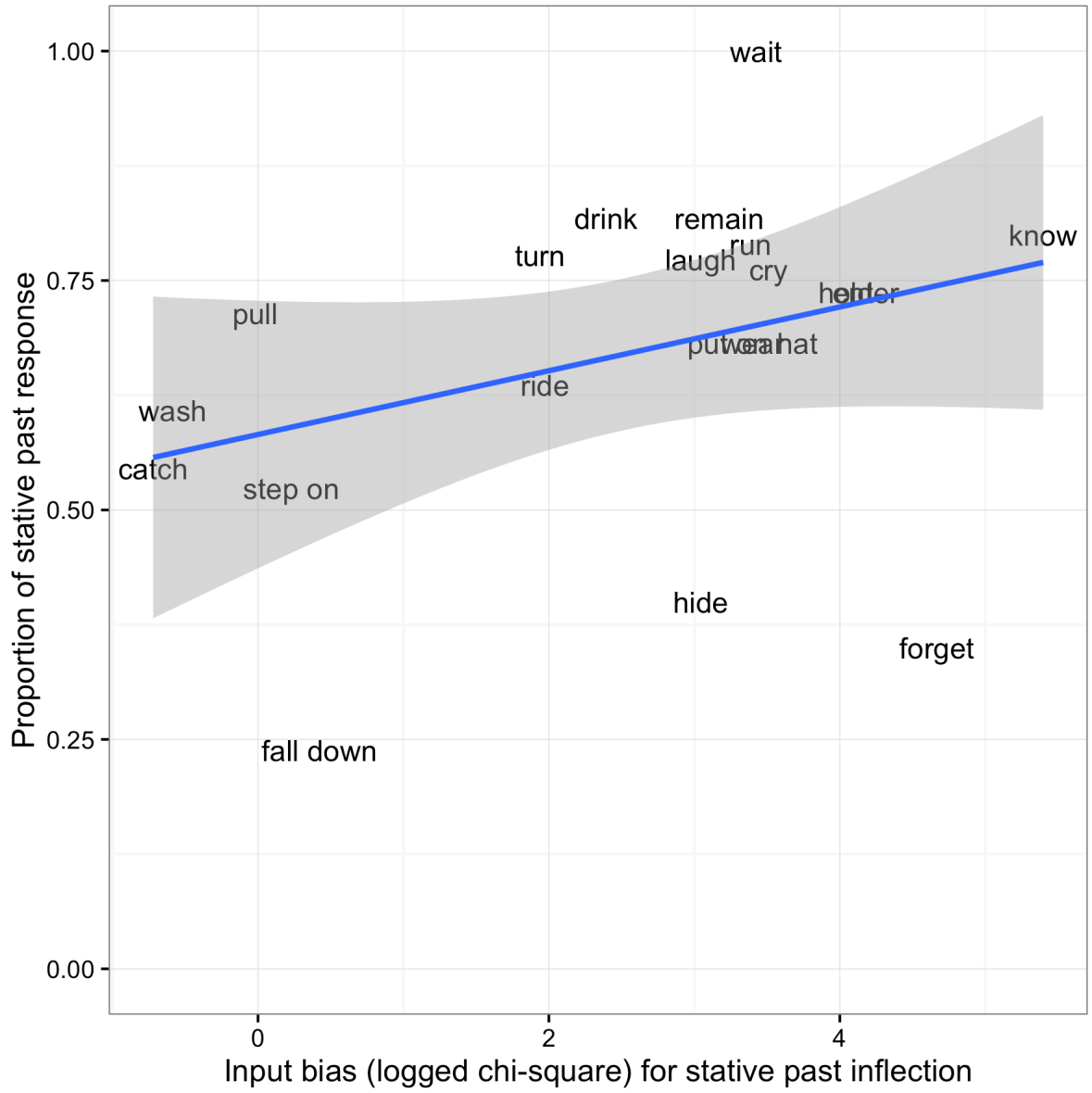


Figure 9. Proportion of children's stative vs simple past forms by input bias (data points are plotted with verb labels in English translation)



4 Discussion (Study 1)

Although the trend was in the predicted direction, Study 1 found no evidence to support the hypothesis that children's relative by-verb production of simple versus complex forms (here, simple- versus stative-past forms) reflects the frequency distribution of these forms in the input.

Of course, one possible reason for this failure to find the predicted effect is that there is no effect to find. Another is the influence of outliers: one (***mat* 'wait'**) produced

exclusively in stative-past form (presumably because waiting tends to constitute a continuous activity) and three (***taore* 'fall down', *kakure* 'hide', *wasure* 'forget'**) produced on over 50% of occasions in simple-past form. Indeed, an analysis of the data with these four verbs removed showed a significant effect of input bias (β= 0.44, SE=0.15, χ^2=6.72 p=0.01), with no significant effect of trial number (β= 0.01, SE=0.02, χ^2=0.02 p=0.88) and no interaction (β= 0.01, SE=0.01, χ^2=1.25, p=0.26). A third possible reason for the lack of an input effect is that children are not sensitive to the very subtle, mainly aspectual, semantic distinction between simple and stative forms. This possibility is supported by the lack of a priming effect, with children consistently producing stative forms at a rate of around 65% from the beginning of the experiment. A fourth and final possible reason for our failure to find an input effect lies with our choice of verbs. As shown in Figure 9, the chi-square value is positive for all but three verbs (*catch, wash* and *pull*) indicating that the majority of verbs chosen as "simple-past-biased" (and showing this bias by binomial test), were actually stative-past-based in the context of the corpus. That is, although the remaining "simple-past-biased" verbs are more frequent in simple- than stative-past in the input corpus, the extent of the bias is smaller than for verbs in the corpus in general; presumably because the design of the experiment forced us to choose "simple-past-biased" verbs that were nevertheless relatively natural in stative past form.

In view of these possibilities, the absence of an input effect in Study 1 is difficult to interpret. We therefore conducted a second study designed to address the potential shortcomings of (1) outlier verbs, (2) insensitivity to the relevant semantic distinction and (3) insufficient manipulation of the input-based predictor. This second study focuses on the completive morpheme, which is both semantically more salient, and also allows for the inclusion of verbs that are genuinely biased towards the simple form.

Study 2: Simple past vs complex completive past

5 Method

5.1 Participants

Thirty children (12 boys and 18 girls) aged 3;5-5;3 (mean=4;2), recruited from nurseries in Tokyo, participated in the experiment. All were native monolingual speakers of Japanese reported as showing no linguistic impairment.

5.2 Design and materials

As in Study 1, children took part in a sentence-completion task that elicited simple past forms and (complex) completive past forms for 20 verbs (10 biased towards simple past and 10 towards completive past forms). These verbs were selected on the basis of the frequency distribution in the input, also taking into account their familiarity for children and the ease with which they could be illustrated. Frequency counts were taken from the same sources as for Study 1. For each verb, the token frequency of (a) the simple past form (e.g. *koware-ta* 'broke') and (b) the completive past form (e.g. *koware-chat-ta* 'ended up breaking') was obtained, using the FREQ function of the CLAN program (MacWhinney, 2000). Simple-past-biased verbs and completive-past-biased verbs (see Table 24) were selected on the basis that the relevant bias was significantly different from chance (i.e., to 0.5 simple past vs stative past) by binomial test ($p<.05$). However, due to the fact that the instances of completive past verbs are not so abundant in the speech sample, we included 7 completive-biased verbs for which the bias did not reach significance. In addition to these 20 target verbs for use by children, 20 unbiased verbs (by binomial test) were selected for use by the experimenter (see Table 24). Again, a chi-square statistic was calculated as a measure of verb bias, in order to take into account the fact that simple past forms outnumber completive past forms (in this dataset by 7,545 to 1047).

Table 24. Verbs for children

					summed input frequency four MOTs		
	verb	meaning	morphological class	Bias	Frequency (simple past)	Frequency (completive past)	Binomial test
C1	moraw	get	Consonant	simple	21	1	<.001
C2	tat	stand	Consonant	simple	10	1	0.001
C3	kaw	buy	Consonant	simple	49	3	<.001
C4	mi	look	Vowel	simple	57	2	<.001
C5	mituke	find	Vowel	simple	14	2	0.002
C6	tukur	make	Consonant	simple	30	1	<.001

C7	ire	put in	Vowel	simple	17	2	<.001
C8	tor	take	Consonant	simple	28	3	<.001
C9	kak	write	Consonant	simple	37	3	<.001
C10	nor	ride	Consonant	simple	16	2	0.000
C11	nakuna r	disappea r	Consonant	completiv e	15	31	0.013
C12	otos	drop	Consonant	completiv e	8	13	0.192
C13	wasure	forget	Vowel	completiv e	5	24	0.000
C14	hazure	come off	Vowel	completiv e	4	9	0.133
C15	koware	break	Vowel	completiv e	17	27	0.087
C16	okkoch i	fall down	Vowel	completiv e	3	10	0.046
C17	ware	split	Vowel	completiv e	2	5	0.227
C18	kire	cut	Vowel	completiv e	1	5	0.109
C19	nak	cry	Consonant	completiv e	8	12	0.252
C20	korob	tumble	Consonant	completiv e	1	4	0.188

Verbs for experimenter

			summed input frequency four MOTs

	verb	meaning	mor class	Bias	freq (simple)	freq (completive)	Binomial test
E1	asob	play	Consonant	unbiased	1	1	0.75
E2	chirakas	mess up	Consonant	unbiased	1	1	0.75
E3	muk	peel	Consonant	unbiased	0	1	0.5
E4	hare	swell	Vowel	unbiased	1	1	0.75
E5	fue	increase	Vowel	unbiased	0	1	0.5
E6	mazar	mix	Consonant	unbiased	1	1	0.75
E7	tomar	stop	Consonant	unbiased	5	4	0.5
E8	nemur	sleep	Consonant	unbiased	1	1	0.75
E9	nokor	be left	Consonant	unbiased	1	1	0.75
E10	or	bend	Consonant	unbiased	1	1	0.75
E11	sime	shut	Vowel	unbiased	1	1	0.75
E12	sugi	pass	Vowel	unbiased	1	1	0.75
E13	tob	fly	Consonant	unbiased	1	1	0.75
E14	tukaw	use	Consonant	unbiased	1	1	0.75
E15	yabur	tear	Consonant	unbiased	0	1	0.5
E16	yuzur	cede	Consonant	unbiased	0	1	0.5
E17	agar	ascend	Consonant	unbiased	1	2	0.5
E18	nug	take off	Consonant	unbiased	1	2	0.5
E19	okor	get angry	Consonant	unbiased	1	2	0.5
E20	watas	give	Consonant	unbiased	1	2	0.5

5.3 Procedure

The procedure was the same as for Study1, the only difference being the use of the completive instead of the stative inflection in the experimenter's prime sentences. The complete list of test sentences is in Appendix C.

5.4 Analyses

Children's responses were dummy coded as 1 if the target verb was used in (complex) completive past form and 0 in simple past form, with all other responses excluded (N= 133). These excluded responses were 59 simple non-past forms (reflecting use of clue words), 2 with a non-target inflection such as stative non-past forms, 52 responses using non-target verbs, and 23 responses of other types such as nouns and adjectives (e.g. *okasi* 'snacks'). Also excluded were a further 5 trials for which children produced no response and 6 trials for which the experimenter failed to provide the correct prime sentence, for a final total of 455 scorable responses; giving an exclusion rate comparable with both Study 1 and previous studies. The data were analysed in the same way as in Study 1, including the use of a chi-square measure as the measure of input bias (here, completive vs simple past).

6 Result and discussion (Study 2)

Table 25 shows the total number of valid responses and the rate of responses in completive past (complex) for verbs with different biases for Study 2.

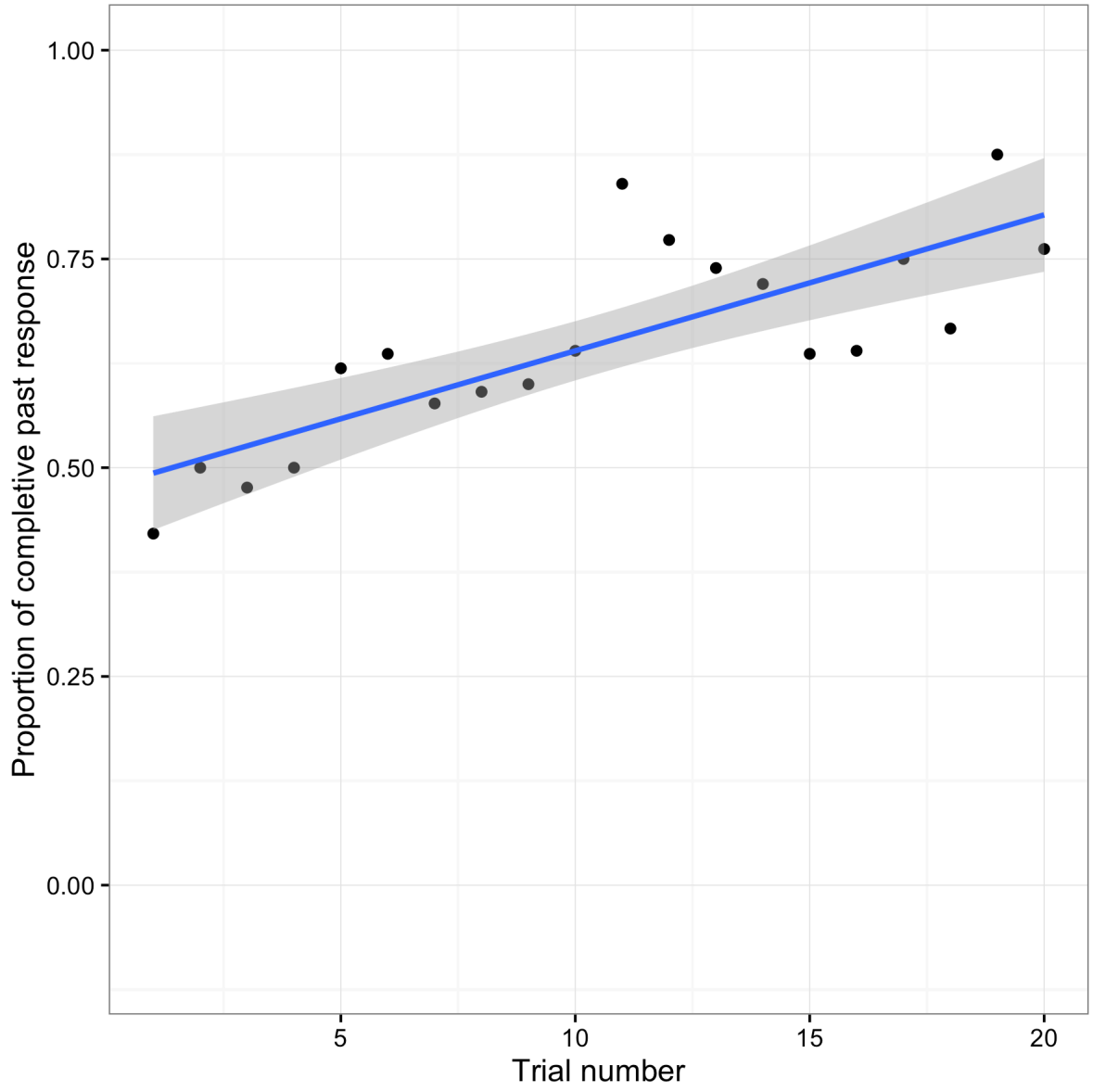
Table 25. Children's responses by verb bias in Study 2

Verb bias	Total number of valid responses	Response in simple past	Response in completive past	Mean responses in completive past	SD
simple past	209	95	114	0.545	0.499
completive past	246	63	183	0.744	0.437

A binomial mixed effect model was fitted to children's responses (completive/simple past forms) with predictor variables of trial number (see Figure 10), completive-vs-simple

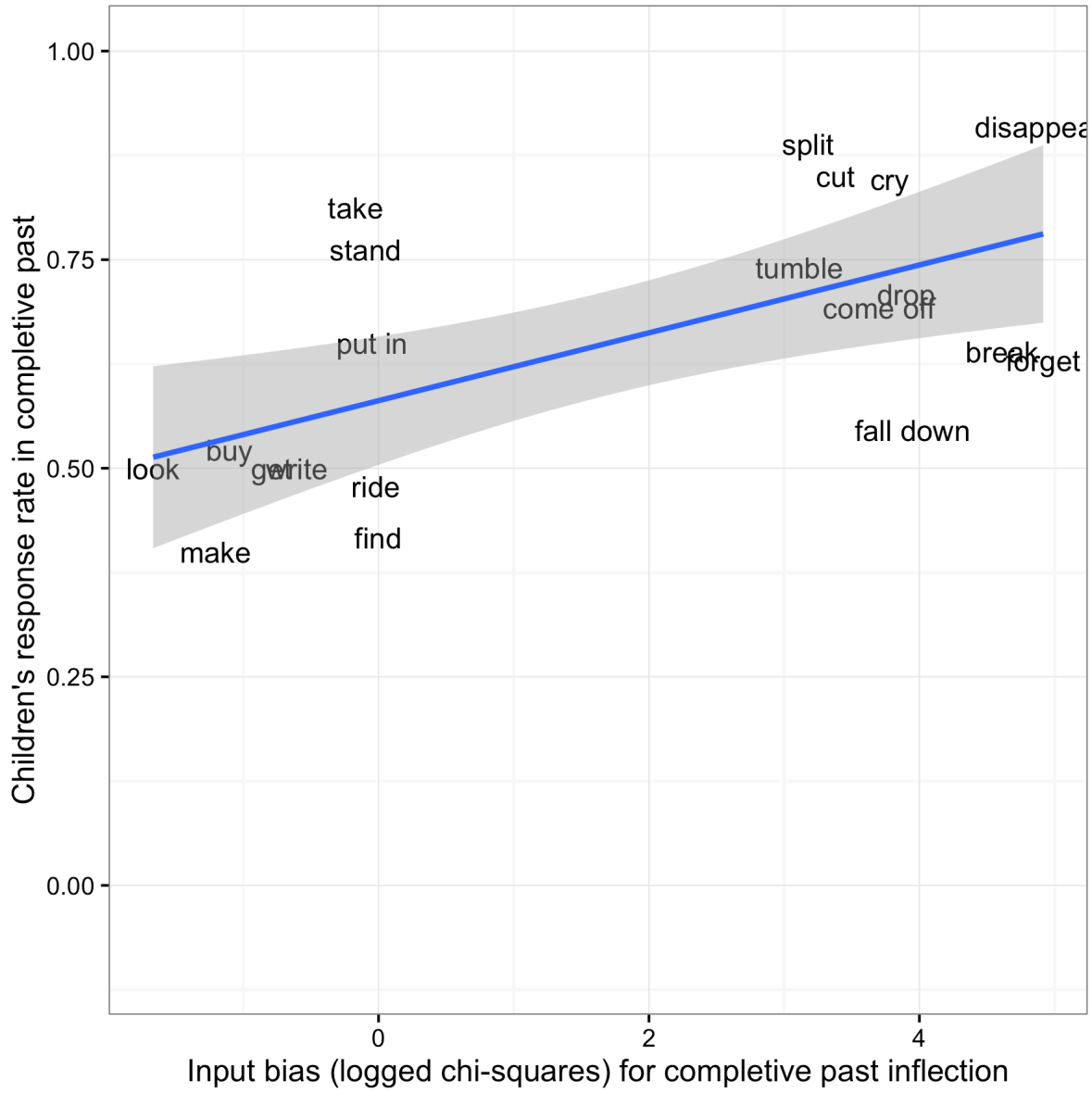
input bias (chi-square measure; see Figure 11) and the interaction between these variables. The final model had by-subject random slopes for the input bias and by-subject and by-item random intercepts.

Figure 10. Proportion of children's completive vs simple past forms by trial number



The model revealed a significant effect of trial number (β=0.38, SE=0.15, χ^2=24.11, p< .001), indicating that children's use of completive past forms increased as a result of the incremental priming of these forms during the test session (see Figure 10).

Figure 11. Proportion of children's completive vs simple past forms by input bias (data points are plotted with verb labels in English translation)



Crucially, the addition of input bias was found to significantly increase model fit (β=0.38, SE=0.15, χ^2= 5.44, *p*=0.02; see Figure 11). Unlike in Study 1, all but one of the verbs selected as simple-biased (*mituke* 'find') did indeed show this bias, relative to the verbs in the corpus as a whole, on the chi-square measure (i.e., the chi-square measure has a negative value). The interaction between these factors did not reach significance (β=0.02, SE=3.00, χ^2= 5.44, *p*=0.08) (though see Footnote 5).

In summary, the findings of Study 2 show that children's choice between simple and completive past forms reflects the probabilistic patterning of these whole inflected forms in the input language. More broadly, these findings suggest that children's knowledge of different inflectional forms reflects the relative strength of these forms in the input, and that the failure of Study 1 to find such an effect is a reflection of our failure to select verbs sufficiently biased towards simple-past forms.

7 General discussion

The goal of the present study was to investigate whether effects of input frequency, as observed in a large number of previous studies, hold after controlling for a potentially confounding factor present in virtually all previous studies: morpho-phonological complexity. The present study focused on Japanese verb inflection, which constitutes a particularly suitable test case, because morpho-phonologically complex forms outnumber simple forms for some verbs, but are less frequent for others. Across both experiments, the prediction of a frequency-based account is that the likelihood with which children will produce simple versus complex forms for each verb reflects the relative frequency of the two forms in the input. Such an effect was found for simple versus complex *completive* past forms (Study 2), but not for simple versus complex *stative* past forms (Study 1).

Although, at first glance, the findings of Study 1 might appear to constitute evidence against a frequency-based account, closer inspection of the set of verbs revealed (as well as number of outliers) an insufficient number that were truly biased towards the simple past form. Although all verbs selected as "simple-past-biased" verbs were more frequent in simple- than stative-past form in the input corpus, for all but three, the extent of the bias was smaller than for verbs in the corpus in general. This problem is difficult to avoid for statives, because the design of the experiment requires that all verbs selected be relatively natural in stative past form, hence ruling out verbs with a large simple-past bias.

For Study 2, we therefore replaced statives with completives as the complex past form. The fact that the predicted effect of input frequency emerged in this study provides support not only for frequency-based accounts, but for the possibility that the failure to find such an effect in Study 1 was due to the methodological problems addressed by Study 2.

Nevertheless, two other differences between the two studies merit further consideration. First, for Study 2 (completives), the observed rates of simple versus complex

form production across verbs were essentially as would be expected on the basis of the input sample, with no clear outliers. In contrast, for Study 1 (statives), one verb (*mat,* 'wait') and three verbs (*taore,* 'fall down'; *kakure,* 'hide'; *wasure,* 'forget') were produced in their complex stative form considerably more and less often respectively than would be expected on the basis of the input. (Indeed, recall that the input predictor reached statistical significance with these outliers removed). The most likely explanation for these outliers is an effect of semantics. Waiting, by its very nature, tends to be a stative activity, while falling-down and (possibly) hiding and forgetting tend to be more eventive or dynamic. These verbs therefore highlight a point that is central to the present article; that any investigation of frequency effects must take great care to control for potentially confounding factors such as morpho-phonological complexity (which we controlled for largely successfully) and verb semantics (which we did not).

This brings us to the second important difference between the two studies. Although both stative (Study 1) and completive (Study 2) inflections mark aspectual distinctions and are roughly equivalent in terms of morpho-phonological properties (*te* vs *chat*), they differ with regard to the semantic distinction that each makes compared to the simple form. In particular, completive forms would seem to be more semantically marked – relative to simple forms – than stative forms. While completive inflection conveys some unexpected or unwanted, often negative implications, statives are more contextually and emotionally neutral. This could explain why children seemed to be relatively insensitive to the priming manipulation for statives (Study 1) as compared to completives (Study 2).

These considerations notwithstanding, the present study provides perhaps the clearest evidence to date for an effect of input frequency on children's acquisition of inflectional morphology. Most – indeed, perhaps all – previous studies that have found apparent effects of input frequency in this domain have failed to control for morpho-phonological complexity (i.e., for the fact that high-frequency forms tend to be shorter and simpler). By focusing on a system that shows by-verb variation in the relative frequency of simple and complex forms, the present study has allowed us to investigate effects of input frequency, controlling for morpho-phonological complexity. An interesting follow-up study would be to conduct the same experiment with adult participants, and to explore the process of acquisition by including adult data as baseline. Similarity between children and adults' response pattern would suggest that the sensitivity to frequency distribution is constant, whereas difference would imply some difference in generalizability or productivity of morphologically simple

and complex inflections, in addition, probably, to different task effects in two groups. While addressing a number of methodological shortcomings of Study 1 (statives), Study 2 (completives) provides support for the prediction of an input-based account that the relative accessibility or representational strength of simple and complex forms of the same verb is related to the relative frequency of these competing forms in the input. A mechanism that can yield such competition effects must therefore lie at the heart of any successful account of the acquisition of inflectional morphology, and, indeed, of child language acquisition in general.

Chapter 8 General discussion

This chapter summarises the results from the four studies and draws out implications for theories of both morphological acquisition and language acquisition more generally.

1. Summary of results

The first study (Chapter 4) addressed the age/order of acquisition of verb inflections using corpus data. The first part of this study showed that there appears to be no fixed common order in the acquisition of inflections. This was investigated by comparing estimates based on different type frequency measures for estimating point at which children acquire productive use of inflections. Three type frequency measures (first occurrence, five types and ten types) yielded different orders, and there was also considerable variation in these orders across children. Moreover, controlling for sampling effects, by looking at caregiver data, reduced the rank order correlation between children, suggesting that the type frequency measures are methodologically problematic. The second part of the study looked at the factors that account for the age of acquisition of verb forms by focusing on input frequency and morphological factors such as the number of morphemes (complexity) and the identity of morphemes. An exploratory analysis using regression models revealed that children tend to acquire forms with higher input frequency earlier than forms with lower input frequency. At the same time, this frequency effect is mediated by the type of medial inflectional morpheme, such that some morphemes such as completive show a greater sensitivity to input frequency compared to other morphemes like stative. The third part of the study clarified the effect of input frequency by controlling for confounded samping effect. These findings suggest a complex picture of the acquisition of Japanese verb inflection, in which children learn whole inflected forms using an input-based learning mechanism, but with the importance of frequency varying depending on the individual inflection.

The second study, a corpus-based investigation of children's use of past and other inflectional verb forms (Chapter 5), contrasted the generativist hypothesis that the past tense form is a default form (RI analogue) and the constructivist hypothesis that children's use of past tense versus other inflectional forms reflects their relative frequency distribution in the input. This study found that children's (aged 1;5 - 2;10) earliest verbs included a range of inflections and that children made errors involving the over-use of several different inflections; contrary to the generativist prediction that children's earliest errors reflect the use of past forms as a default (and therefore in all or most error contexts). Following these descriptive analyses, correlational analyses showed that the frequency distribution of past

versus other inflections in children's speech is explained by the corresponding distribution in their individual caregivers' input. The correlation held even after controlling for the averaged relative frequency of these forms computed from the child-directed speech of the caregivers of other children, which controls for the general effect of the semantic-distributional properties of the language (and hence for sampling effects). These findings constitute evidence for a constructivist view that predicts frequency-based competition between inflections, and against the generativist view of default-like usage of a particular inflection. The fact that children's verb-specific usage pattern of inflections reflects the pattern in their own caregivers' input over and above the effect of frequency distribution of child-directed speech in general provides particularly strong support for constructivist accounts.

Chapter 6 extended the findings of Chapter 5 by using an elicitation paradigm to look for verb-specific patterns of inflectional errors in child Japanese, focusing again on the over-use of past-tense forms as a possible default. This experimental approach, which used a sentence-completion task, was particularly useful for eliciting errors that are rarely produced and/or difficult to detect in naturalistic speech data. This study tested the constructivist prediction that children's inflectional errors reflect the probabilistic competition between inflectional forms in a way that is related to the frequency distribution of these forms in the input language. The study also tested the competing generativist claim that children's errors reflect a categorical defaulting pattern, namely the over-use of past forms, as predicted by Murasugi (2015); in line with other generativist claims based on formal grammatical distinctions (i.e., the Root Infinitive literature). The experiment elicited past and nonpast tensed forms for verbs that were biased either toward past or toward nonpast inflection in terms of the frequency distribution of these two inflections in child-directed speech. This allowed for investigation of the constructivist prediction that children will make errors of using past forms in nonpast contexts and vice versa, depending on the relative frequency of these two forms of the particular verb in the input. Two experiments confirmed that children (aged 2;7-5;8) indeed showed the predicted bi-directional pattern of inflectional errors, such that the likelihood of occurrence of each types of errors was explained by the by-verb relative frequency of past and nonpast forms in a sample of child-directed speech. At the same time, however, the results also showed higher rates of past than nonpast inflection in children's production (including errors). The reason for this pattern is not clear, but one possible factor is the higher degree of phonological regularity of past inflection compared to nonpast inflection. Although this bias for past inflection was not expected, this cannot be considered as an evidence for categorical defaulting to past inflection, given children's observed

sensitivity to the probabilistic distributional patterns in the input language. This bias instead seems to suggest the role of factors other than input frequency, such as phonological regularity.

In light of this conclusion, Chapter 7 presented another experimental study designed specifically to pick apart effects of input frequency and (morpho-)phonological complexity. Specifically, the aim of this study was to look at whether effects of frequency (as observed in the studies reported in Chapter 6) hold even after controlling for complexity, by investigating children's elicited production of morphologically simple and complex forms. Morpho-phonological complexity constitutes a problem for previous studies that reported (apparent) effects of input frequency, because frequency is confounded with complexity; complex forms tend to be low in frequency and simple forms tend to be high in frequency, as a general distributional property of language (e.g. Anglin et al., 1993). In order to disentangle these factors, children's (aged 3;3-5;3) production of morphologically simple (simple past inflection) and complex (stative past inflection for Study1 and completive past inflection for Study 2) verb forms was elicited for verbs that were biased toward either the simple or the complex form in terms of relative input frequency (again in a sample of child-directed speech). The first part of the study, which looked at simple past and stative past inflections, did not find any effect of input frequency. However, this null finding appeared to be due primarily to the failure to select verbs that exhibited a sufficiently strong simple-past bias, relative to the language in general. Study 2, designed to correct this methodological problem, investigated another inflection pair, simple past and completive past inflections (for which it is easier to find genuinely biased verbs), and found that children's production rate of simple and completive past forms was predicted by the by-verb frequency distribution of these forms in child-directed speech. This result suggests that the effect of input frequency on different verb forms is observed over and above morphological complexity.

In sum, all four studies have provided support for a constructivist learning account of verb inflection, here focusing on Japanese. Although these studies have raised a number of methodological issues and some results that need further investigation, all four have shown that the verb-specific distribution in children's use of different inflections is explained by frequency-based competition of these forms in the input. This consistent pattern constitutes strong evidence for the argument that children's inflectional knowledge is learnt on the basis of the input. This raises the question of more the general theoretical (and also

methodological) conclusions that can be drawn from these findings; a question discussed in the following sections.

2. Methodological considerations when investigating input frequency

The success of the present studies in uncovering frequency effects hinges in particular on two methodological strengths: an attempt control for confounding effect and a focus on frequency at a lexical level.

All four studies in this thesis took into consideration the effect of confounding factors in the analyses investigating the effect of input frequency. One of these confounds is the sampling effect. Language is probabilistically patterned such that a very small number of words have very high frequency and the majority of words have low frequency (Zipf's law, Ellis, 2005; Zipf 1935). A consequence of this distribution is that high frequency words are much more likely to be sampled than low frequency words. Although this issue is recognised in the field (e.g. Tomasello & Stahl, 2004; Rowland & Fletcher, 2006), many studies looking for effects of frequency using naturalistic speech data have not included methods designed to control for this confound. All four studies reported here, however, did so. In Chapter 4 (corpus-based study), the rank-order correlation between the order of acquisition of inflections between different children was investigated after partialing out the token frequency of these inflections, in order to see whether any similarity in the rank order is due to a sampling effect. A regression analysis in this chapter, analysed the effect of input frequency of whole inflected forms on the age of acquisition of these forms, over and above two control variables: the frequency of the relevant (1) verb form and (2)inflectional morphemes. Chapter 5 (another corpus-based study) controlled for sampling effects by distinguishing individual and averaged input-frequency measures. This study looked at the effect of the input frequency of forms in each child's individual caregiver, after partialling out averaged input frequency from other children's caregivers.

This sampling issue is not the only potential confound in research on children's acquisition of morphology. The experimental study on children's errors with past and nonpast tense inflections (Chapter 6) was designed to address a different kind of confound: that, in many cases, verb forms from a single inflectional category (e.g, English nonfinite/bare-stem forms; Spanish 3sg forms) tend to constitute the vast majority of tokens of that verb. This tendency is found in many languages, and causes difficulty in answering the question of whether an observed pattern in child language is associated with the grammatical category

(e.g. “basicness”/nonfiniteness per se) or with input frequency (i.e., the fact that, for virtually every English verb, bare/nonfinite tokens predominate). By focusing on Japanese, a language with two roughly equally basic and frequent inflectional categories (past and nonpast), this study was able to address the confound between inflectional category and frequency of use. Similarly, the experimental study of morphologically simple and complex inflections (Chapter 7) revealed an effect of frequency even after controlling for the confounding factor of morphological complexity: Simple forms are generally more frequent than complex forms. This study extended the input-based explanation developed for past and nonpast forms (Chapter 6) to a range of different inflections, which is important especially for understanding children’s acquisition of morphologically rich languages. The measures taken to control for confounding factors have played an essential role by allowing the present studies to uncover apparently genuine effects of input frequency, thus providing strong support for constructivist predictions.

Another important feature of the studies in the current thesis is its focus on lexically specific frequency (i.e., frequency of individual lexical verb forms, as opposed to solely of inflections). The studies in Chapters 5-7 all used, as dependent measures, the relative or proportional token frequency of different inflectional forms of each verb and detected the effect of this factor in children’s production of inflectional forms. Because the theoretical predictions from generativist and constructivist accounts contrast sharply with regard to the relevance of distributional patterns of inflectional forms in child language, examining whether verb-specific frequency explains children’s use and rates of error can directly distinguish these predictions (e.g., Dąbrowska, 2006; Lieven, 2010). The effect of this frequency factor (replicated across Chapters 5-7) suggests that the relative representational strength of different inflectional forms of each verb in children’s language reflects probabilistic distributional properties of the input. This verb-specific pattern is not predicted by any account that makes reference solely to grammatical or inflectional *categories*, but instead constitutes strong evidence for the input-based learning view. Effects of item-specific frequency have been found previously in other languages (e.g. English and Finnish: Räsänen et al., 2014; 2015), but are most clearly seen in Japanese, in which the frequency distribution of inflectional forms of interest varies considerably from one verb to another, hence allowing us to rule out an alternative explanation based on grammatical distinctions; for example that the nonfinite (English), 3sg (Spanish) or past-tense (Japanese) form constitutes a grammatical default.

3. Input-based versus categorical learning of verb inflection

The crux of the current thesis is the claim that children's knowledge of verb inflection is acquired on the basis of the input language. The demonstration of a relationship between child and input language in terms of item-specific distribution constitutes strong support for this constructivist claim and against the more categorical claims of other theoretical views, particularly generativist explanations based on grammatical categories.

The fundamental assumption of these accounts is that grammar is a set of rules and constraints that are either innate or acquired by minimal amount of exposure to the ambient language (cf. Hyams, 1986; Guasti, 2004; Snyder & Lillo-Martin, 2011). Generativist explanations of the acquisition of verb inflection typically centre around defining the order of parameters that come online (e.g. Wexler, 1994; 1998), due to mechanisms such as maturation (e.g. Radford, 1990; Sano, 2002) or the "withering away" of developmental constraints (e.g. Unique Checking Constraint, Wexler, 1994; 1998), characterised in terms of grammatical categories such as agreement or tense features. Another important characteristic of this approach is the clear distinction between the lexicon and morphosyntax (the grammar). Any available morphosyntactic operation is fully generative, in the sense that speakers can apply the structural pattern to any word in their lexicon. These categorical and productive explanations from the generativist approach do not fit the probabilistic patterns that have been observed in the current thesis. More specifically, the item-specific distributional pattern of different inflectional forms, such as the different distributions of past and nonpast inflections between (for example) *eat* and *drink*, cannot be accounted for in terms of grammatical categories like tense or inflection. Yet it is solely these type of morphosyntactic features that are used, in generativist hypotheses, to explain RI errors or person-number agreement errors (cf. small clause hypothesis: Agreement/Tense Omission Model: Radford, 1996; Schütze & Wexler, 1996; Wexler, 1998; Variational learning model: Legate and Yang, 2007; Yang, 2002; RI analogue hypothesis: Hyams, 2005; Salustri & Hyams, 2003; underspecification of number/agreement: Grinstead, 2000; Hoekstra & Hyams, 1995; 1998).

On the other hand, these observed effects of item-level frequency give strong support to the input-based learning mechanism that constitutes the heart of usage-based and constructivist theories of language acquisition. These theories consider grammar to be emergent from language use (e.g,., Bybee, 2006; 2010, Croft & Cruise, 2004; Tomasello, 2000; 2003), and thus assume that children build their grammatical knowledge on the basis of

the linguistic instances they hear or experience, using a range of domain-general learning mechanisms such as analogy, schema-formation, categorization and cultural learning. A mechanism that is particularly relevant to the findings of this thesis is *entrenchment*, which refers to the process by which stored instances become strongly represented in memory. The repeated experience of an instance, measured by token frequency, promotes entrenchment of the representation of the relevant linguistic form, enabling the user to access and fluently use it as a whole (e.g. Langacker 1988; Krug 1998; Bybee, 2006; Bybee and Schiebman 1999, Schmid, 2007; Tomasello, 2000). This cognitive process is considered to be caused by the entrenchment of neuromotor patterns, which is not only observed in the linguistic domain but also in other cognitive domains such as reasoning (e.g. Dane, 2010; Gärdenfors & Makinson, 1988; Moreau, Lehmann & Markman, 2001). From a wider perspective, this type of perceptual and automatic entrenchment is directly related to chunking mechanisms, as some information is grouped and represented strongly against other information (Gobet, 2017). The frequency effects observed in the present study thus connect not only morphological acquisition and language acquisition, but link these processes to a more general learning mechanism that we use for different kinds of cognitive events and representations.

4. Item-specific and lexical nature in children's early inflection

Even under constructivist accounts, children are assumed to *begin* to build more general morphological representations as soon as they have stored a handful of verb forms. Nevertheless, the results of the studies reported in this thesis emphasise the lexical and non-productive nature of children's early knowledge of verb inflection, in two ways.

The first evidence is from effects of the relative frequency of different inflectional forms of the same verb. The fact that effects of verb-specific distributional patterns were observed (rather than of verb-general patterns) implies that the inflections are not rapidly generalised across verbs. For example, when learning different inflectional forms of the same verb (e.g. *tabe-ru* (eat-NONPAST) and *tabe-ta* (eat-PAST)) children learn one better than the other, with their relative strength determined by the relative frequency of these forms in the input. If children were rapidly abstracting and generalising the morphological pattern of nonpast (-(*r*)*u*) past marking (-*ta*/*da*), as accounts assuming early productivity would predict, the frequency distribution of these two inflections should have been similar or identical across verbs (particularly in the experimental studies that control for the frequency of each context). An effect of an item-specific distributional pattern was observed in the present

thesis for many different form pairs: Chapter 4 focused on the relative frequency of past vs. all other inflections to look at children's usage pattern. Chapter 5 looked at the competition between past and nonpast inflections, and Chapter 6 looked at the competition between (simple) past and stative past, and between (simple) past and completive past inflections; in each case on a verb-to-verb basis. The frequency effects observed for these form pairs can be interpreted in terms of schemas of morphological relations, as proposed by Bybee (1985; 1991) and also of lexical specificity as proposed in the Verb Island Hypothesis (Tomasello, 1992). Young children's knowledge of different inflectional forms may be linked at the lexical level, in such a way that inflectional variants of a verb are grouped together by semantic and phonological similarities (e.g. *taberu*, *tabeta*, *tabechatta* etc. for the verb of eating), but these forms appear not to be associated with those inflectional variants of other verbs (e.g. *nomu, nonda, nonjatta* etc. for the verb of drinking).

The second (and related) piece of evidence for early lexical specificity is from the observed effects of whole word frequency in all the studies of the thesis. The effect of this kind of frequency measure suggests that children's learning is characterised as the direct learning of forms from the input, and children's linguistic representations consist solely or mainly of whole inflected words, even if these forms are, in principle, segmentable from a linguistic point of view. Although this interpretation does not preclude the possibility that children also have emerging abstract knowledge of inflectional patterns, it clearly suggests lexical learning especially during the early stages of verb use. For example, young children's knowledge of past inflection consists of knowledge of specific instances such as *asonda* and *tabeta* ('played' and 'ate') rather of a morphological inflection like *–ta/da*. Only later are children assumed to gradually develop abstract morphological knowledge, by figuring out the patterns that are shared across these individual instances (i.e., exemplar-based learning: Ambridge et al., 2015; Bybee, 2006; Dąbrowska, 2008). In addition to the effect of whole word frequency, the observed relationship between child and child-directed speech (e.g. Chapter 4) highlights the relatively conservative nature of early Japanese; a finding supported also by a number of previous studies that reported very few inflectional errors in Japanese (e.g. Clancy, 1985). More generally, these findings are in line with a number of studies that have reported apparent effects of conservatism: children's failure or reluctance to generalise a construction to new verbs (cf. Akhtar & Tomasello, 1997; Bowerman, 1978; Brooks, & Tomasello, 1999; Pinker, Lebeaux, & Frost, 1987).

The lexically-specific and non-productive nature of early inflection maps well on to the constructivist view that children's verb inflection is item-specific early on and becomes abstract and productive gradually (e.g., Bybee, 2010; Dąbrowska & Lieven 2005; Ellis, 2002; Lieven et al., 1997; Pine and Lieven 1993). This finding counts against the generativist assumption that even very young children's inflection is productive and can be applied to all verbs in their lexicon (e.g. Wexler, 1994; 1998).

At the same time, the development of productivity in the acquisition of Japanese verb inflection has not been studied in either the current studies or previous research, and so constitutes an important topic for future research (perhaps using novel verbs). Although the current thesis provided evidence for early non-productive knowledge of inflection, children will – on any account – at some point be able to recognise the morphological patterns that are common across different verbs and to generalise these patterns to new verbs. At the same time, however, the constructivist view does not necessarily assume across-the-board full productivity of all inflections even for adults' linguistic knowledge, which follows from the basic assumption that our linguistic knowledge is constantly shaped on the basis of experienced instances (e.g. Bybee; 2006; Bybee & Slobin, 1982; Dąbrowska, 2008, Dabrowska, & Szczerbinski, 2006; Stemberger, & MacWhinney, 1986; Wray & Perkins, 2000). In fact, studies such as Klafehn (2003) and Vance (1991), who showed a relatively poor performance in inflecting novel verbs in Japanese, seem to support the partly unproductive nature of adult inflectional knowledge. This leaves the possibility that item-specific and non-productive nature of inflection persists to some extent even in adult language.

5. Acquisition of verb inflection in Japanese and in general

Japanese has grammatical and distributional properties that are not shared with English and other major European languages. Particularly important characteristics for the current thesis have been the morphologically rich verb inflectional system and the by-verb frequency distribution of inflections in usage. These characteristics allowed the studies to distinguish different predictions from constructivist and generativist theories: item-specific or categorical distributions in children's use of different inflectional verb forms, both correct uses and errors. While the aim of testing these predictions was to draw general conclusions of theories of language acquisition, the individual studies of the paper also revealed different aspects of

acquisition that are specific to Japanese. This section summarises the language-specific and language-general implications from the results of these studies.

5.1 Language-specific implications

First of all, the specific patterns observed in children's production were the product of the grammatical and probabilistic distributional properties of Japanese. For example, Chapter 4 demonstrated that the order of acquisition of verb inflections shows little consistency. The earliest verb forms include past, nonpast, imperative and completive past forms, and individual variations across children is considerable. Even some morphologically complex forms such as completive past occur early. Similar variation is found also in children's errors. The corpus analysis reported in Chapter 5 found that children made errors for different inflections, for example producing past instead of aspectual past or nonpast instead of past. Variation in the kind of errors observed (i.e., different combinations of error and target forms) is one of the interesting and characteristic features of Japanese. Chapter 6 focused on past and nonpast inflections and found a bi-directional error pattern in children's elicited production. This specific error pattern was predicted on the basis of the linguistic and probabilistic properties of Japanese. Chapter 7 also looked at competition between two inflectional forms, simple past and stative/completive past, and again detected frequency-based competition between these morphologically simple and complex forms. This prediction, and subsequent finding was made possible by agglutinative variations in the inflectional morphology of Japanese. In addition, the large number of distinctions in verb inflection allows for the observation of considerable variation across different speakers (unlike, for example, for English), allowing the study reported in Chapter 5 to differentiate effects of input frequency of the individual caregiver's input and the averaged input.

Another interesting language-specific finding is the importance of the type of inflection on acquisition. The study on the order/age of acquisition reported in Chapter 4 found that children's sensitivity to the input frequency is mediated by the type of inflection. This finding suggests that children may learn different inflections using different learning strategies. For example, children may generalise aspectual inflection across verbs, but need the input of the exact inflected forms to learn completive forms. The study reported in Chapter 7, of children's production of simple and complex inflections (simple past vs. stative/completive past inflections), may also suggest an effect of particular properties of inflection. Although the different results observed for stative and completive inflection were attributed mostly to methodological differences between the experiments, it is also worth

considering the possibility that particular properties of stative and completive inflections, including their phonological, grammatical and semantic/pragmatic properties, could lead to different rates of production and priming for the two inflections. This would suggest a complex picture of the acquisition of inflection whereby the properties of different inflectional morphemes (beyond simply their frequency) affect the learning process.

The studies in the current thesis have also confirmed a number of tendencies that have been reported in previous studies. First, the corpus study reported in Chapter 5 replicated previous findings of a low rate of inflectional errors in children's naturalistic speech, which has been considered as a characteristics of Japanese acquisition (e.g. Clancy, 1985; Kato et al. 2003). However, taken together with the findings of the other studies reported in this thesis, these low error rates seem to reflect not – as has usually been argued – early mastery of the system, but young children's dependence on lexical learning, as reflected by the surface frequency effects reported in Chapters 4-7. Morphological errors would be expected to be rare if children store and retrieve correct inflected verb forms that are learnt directly from the input. In addition, the use of stored inflected forms makes it difficult for researchers to detect syntactic errors with these verb forms, particularly given the context-dependent nature of Japanese grammar that allows different word orders, ellipsis of arguments and so on.

Second, the corpus studies reported in Chapter 4 and 5 corroborated the early occurrence of many different inflections in child Japanese, as has been reported in several previous studies (e.g. Clancy, 1985; Okubo, 1967; Rispoli, 1981). Again, however, the effects of whole-form input frequency observed throughout this thesis suggest that these early inflected forms are likely to be learnt as whole forms rather than to reflect productive combination of morphemes. It is likely that the importance of lexical learning is more pronounced in Japanese than in other languages, due to features that make the extraction of morphological patterns relatively difficult. These features include the lack of available "base" verb forms (e.g. bare/infinitive forms in English) and the relatively large number of inflectional distinctions that can be marked on a verb; factors also mentioned in previous studies (e.g. Clancy, 1985; Shirai & Miyata, 2006).

5.2 Language-general implications

The most important theoretical implication of the current thesis is the item-specific nature of children's early inflection, which was shown by the numerous observed effects of by-verb relative frequency of inflected forms in the input language. These results provide a support

for the constructivist assumption that children's grammatical knowledge develops on the basis of the input. In fact, a relationship between relative performance for different inflected forms in child language and the distribution of these forms in the input has been observed in previous studies of several different kinds of phenomena in different languages (e.g. bare/infinitive form errors in English: Räsänen et al., 2014; person-number agreement in Spanish: Aguado-Orea, & Pine, 2015; person-number agreement in Finnish, Räsänen et al., 2015). The current thesis therefore represents an addition to this growing body of literature. Thus converging evidence from different languages corroborates the general importance of input-based learning in the acquisition of inflection. At the same time, these studies underline the need to distinguish the language-specific and language-general factors that together result in observed phenomena or patterns in child language. Because different languages have different grammatical systems and probabilistic patterns of usage, the precise nature of the input-based effects observed varies from language to language. For example, by-verb bidirectional errors were observed for Japanese (e.g. past for nonpast errors and vice versa), whereas English shows a by-verb unidirectional error pattern regarding omission of third person singular agreement *-s* (e.g. Hoekstra & Hyams, 1998; Räsänen et al, 2014). Dutch has multiple default forms for plural noun inflection (Marcus, Brinkmann, Clahsen, Wiese, & Pinker, 1995), while Polish genitive case inflection does not show any default pattern (Dąbrowska, 2001). Comparing the results from studies of different languages is an important way to understand the general mechanism of language acquisition, because it allows us to abstract the core mechanism from various observed phenomena that are each bound to the particular properties of individual languages.

The item-specific nature of inflectional knowledge in early Japanese is in line with other studies of children's acquisition of inflection in other languages (e.g. Dąbrowska and Lieven. 2005; Wilson, 2003), and thus strengthens the argument that children's early inflectional knowledge is low-scope and mostly lexical in nature. In addition, these findings for morphological inflection can also be related to a large body of literature on the acquisition of syntax that provides evidence for the lexically restricted nature of children's early multi-word utterances and syntactic structures (e.g. Cameron-Faulkner, Lieven, and Tomasello, 2003; Lieven, Befrens, Speares, & Tomasello, 2003; Pine & Lieven, 1997; Theakston, Lieven, Pine & Rowland, 2002, Tomasello, 1992). For example, an unanalysed multi-morphemic forms (e.g. *siranai* (know-NEGATIVE-NONPAST) '(I) don't know') in child Japanese can be considered parallel to an unanalysed multiword utterance (e.g. *I don't know*) in child English (or even adult English, e.g. Bybee & Scheibman, 1999). Regardless of whether an

expression of interest is linguistically defined as a combination of morphemes or words, the literature, including the current thesis, suggests that children's early language is low in abstractness and productivity. The importance of the learning of whole inflected forms and the verb-specific distributional patterns of inflection shown in the current thesis supports the claim of usage-based approaches that productivity develops only gradually and in a piecemeal fashion, and has its origins in exemplar-based learning of experienced instances of relevant forms (e.g. Bybee, 2006; 2010; Dąbrowska, 2006; Tomasello, 2000). This claim of early non-productivity has been supported by a number of studies showing item-based distributional patterns in children's naturalistic speech data, and children's poor performance in using novel words in unattested constructions in experimental settings (e.g. see Tomasello, 2000, 2003, for reviews).

Given the importance to the usage-based view of productivity, this constitutes a phenomenon that should be studied developmentally from different perspectives. One important perspective is cross-linguistic: Children's morphological productivity is influenced by language-specific properties (e.g. Dressler, 2005). Some languages (like English) allow children to extract inflectional patterns relatively easily due to the small number of inflectional categories and/or relatively segmentable inflectional forms (e.g. a clear base form and the addition of inflectional morpheme), though the preponderance of base forms seems also to hinder acquisition (e.g. Freudenthal, Pine & Gobet, 2010). Other languages (like Japanese) have more complex systems of agglutinative morphology, and so seem to favour the learning of whole multi-morphemic words.

Another important perspective from which to investigate productivity is in terms of its interaction with different factors. Given the evidence from many studies of *partial* productivity in early language (e.g. Gathercole et al., 1999; Lieven et al., 1997), it is now widely recognised that productivity is mediated by different factors including phonological, semantic and functional properties of specific inflections (e.g. Aguado-Orea & Pine, 2015; Dąbrowska, 2008; Kirjavainen, Nikolaev, & Kidd, 2012), as shown also in Chapters 4 and 7 of the current thesis. Studying productivity further from developmental, crosslinguistic and interacting-factors perspectives will allow us to analyse this aspect of language acquisition, in order to draw general conclusions regarding the nature of the learning mechanism.

6. Concluding remarks and suggestions for future research

The findings summarised in the current thesis, from two studies using naturalistic methods and two studies using experimental methods, provide support for constructivist accounts of children's acquisition of inflection. At the same time, though, the results of these studies have left unanswered several questions that need further investigation.

First, the experimental study reported in Chapter 6 found a general past bias in children's production: Although children's relative use of past and nonpast forms was significantly correlated with input frequency, children additionally produced more past forms than nonpast forms. The possible explanation suggested in this chapter – that past forms are more regular/predictable – should be investigated directly in future studies.

Second, the two experiments reported in Chapter 7, which investigated the production of morphologically simple and complex verb forms, generated different results: The experiment comparing simple and stative past forms did not show an effect of input frequency while the experiment comparing simple and completive past forms did so. These unexpected results were explained largely in terms of the experimental design (i.e., the extent of bias of the verbs chosen), but may also reflect specific phonological, morphological or semantic properties of the linguistic items used in the experiments. Future studies designed to systematically investigate each of these possibilities (for example, by using novel verbs with carefully controlled phonology and semantics) would help to clarify this issue. In the mean time, the present findings already suggest a more complex picture of the acquisition of verb inflection in Japanese. In particular, the importance of properties of individual inflections (e.g. the specific semantic and pragmatic function of stative inflection) was suggested by the studies reported in Chapters 4 and 7. Phonological properties of individual inflections (i.e., past and nonpast have different shapes and different phonological alternation patterns) were discussed as a factor likely to influence error rates in Chapter 6. Further studying specific verb- and inflection-level properties beyond input frequency will help us better understand the complex process of acquisition of verb inflection.

Third, while the present findings emphasise early input-based learning of whole forms and limited productivity, how children later develop abstract inflectional knowledge is an important question that the present thesis – and indeed the constructivist approach in general – has not yet answered. At the same time, it is also crucial to study how much abstractness or productivity we should attribute to the adult language, the end state of language acquisition. In many cases, naturalistic adult speech also looks very lexically restricted, particularly in

terms of verb inflection (e.g. Aguado-Orea & Pine, 2015), so, when investigating productivity with naturalistic data, it is important to use adult speech as a benchmark (as was done in the present thesis, but not the majority of previous studies).

Fourth, although the present thesis has offered several speculations regarding the grammatical and probabilistic distributional properties of Japanese that seem to favour lexical learning (as compared with, for example, English), investigating this issue directly was beyond the scope of the present thesis. Well controlled quantitative comparative studies of the inflectional systems of different languages – while extremely difficult to do fairly – would be useful for exploring the gradual development of abstract or productive aspects of inflection.

Finally, although framed mainly in terms of morphology, the studies reported in the present thesis in fact have implications for what have traditionally been considered different subfields of research on child language including the lexicon, morphology and syntax. The observed importance of whole-word representation (lexicon) of morphologically segmentable forms that mark syntactic distinctions implies that the traditional division of such phenomena into (at least) three distinct subfields is not psychologically real. Indeed, according to usage-based theories, the representations that characterise speakers' linguistic knowledge are the same across (traditionally) different types of linguistic units; all linguistic expressions constitute a pairing of form and meaning, with the degree of internal complexity /compositionality depending on usage (e.g., Croft, & Cruse, 2004; Goldberg, 2003; Langacker, 1987; Tomasello, 2000). This claim of uniform representation has been influential in the field but has rarely been specifically tested in empirical studies. Empirical research on patterns of children's language use which draws together insights and analysis techniques from traditionally-separate subfields of acquisition (e.g. lexicon, morphology, syntax) would allow us to discover which categories and units are psychologically real. Such a research programme, to which the current work represents an initial contribution, would significantly advance our understanding of child language and of language and its acquisition in general.

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List of abbreviations

CV	consonant vowel
D	determiner
DP	determiner phrase
INFL	inflection
IP	inflectional phrase
LAD	Language Acquisition Device
MLU	mean length of utterance
MOSAIC	Model of Syntax Acquisition in Children
N	noun
NP	noun phrase
OI	Optional Infinitive

SOV	Subject-Object-Verb
TNS	tense
TP	tensed phrase
T’	intermediate projection (of Tense)
UCC	Unique Checking Constraint
UG	Universal Grammar
V	verb
VEKI	Very Early Knowledge of Inflection
VEPS	Very Early Parameter-Setting
VLM	Variational Learning Model
VP	verb phrase

Appendices

Appendix A. Complete set of test sentences used in Chapter 6.

verb	meaning	bias	Test sentences
Warm-up sentences (Nonpast target) for Study 1			
araw	wash	unbiased	Asita wa hareru. Kanachan wa asita te o (arau). It will be sunny tomorrow. Kana-chan will wash her hands tomorrow.
nom	drink	unbiased	*Asita wa kumoru. Kanachan wa asita juusu o (nomu).* It will be clouded tomorrow. Kana-chan will drink juice tomorrow.
Warm-up sentences (Past target) for Study 1			
araw	wash	unbiased	*Kinoo wa hareta. Kanachan wa kinoo te o (aratta).* It was sunny yesterday. Kana-chan washed her hands yesterday.
nom	drink	unbiased	*Kinoo wa kumotta. Kanachan wa kinoo juusu o (nonda).* It was clouded yesterday. Kana-chan drank juice yesterday.
Warm-up sentences (Nonpast target) for Study 2			
araw	wash	unbiased	*Asita wa hareru. Kanachan wa asita te o (arau).* It will be sunny tomorrow. Kana-chan will wash her hands tomorrow.
nom	drink	unbiased	*Asita wa kumoru. Kanachan wa asita juusu o (nomu).* It will be clouded tomorrow. Kana-chan will drink juice tomorrow.
nak	cry	unbiased	*Asita wa hareru. Kanachan wa asita (naku).* It will be sunny tomorrow. Kana-chan will cry tomorrow.
koware	break	unbiased	*Asita wa ame ga furu. Kanachan no omocha wa asita (kowareru).*

			It will rain tomorrow. Kana-chan's toy will break up tomorrow.
hak	wear	unbiased	*Asita wa hareru. Kanachan wa asita sukaato o (haku).* It will be sunny tomorrow. Kana-chan will wear a skirt tomorrow.
odor	dance	unbiased	*Asita wa kumoru. Kanachan wa asita (odoru).* It will be clouded tomorrow. Kana-chan will dance tomorrow.
utaw	sing	unbiased	*Asita wa ame ga furu. Kanachan wa asita uta o (utau).* It will rain tomorrow. Kana-chan will sing a song tomorrow.
ker	kick	unbiased	*Asita wa hareru. Kanachan wa asita booru o (keru).* It will be sunny tomorrow. Kana-chan will kick a ball tomorrow.
hik	play instruments	unbiased	*Asita wa kumoru. Kanachan wa asita gitaa o (hiku).* It will be clouded tomorrow. Kana-chan will play the guitar tomorrow.
mawas	spin	unbiased	*Asita wa hareru. Kanachan wa asita koma o (mawasu).* It will be sunny tomorrow. Kana-chan will spin a top tomorrow.
Warm-up sentences (Past target) for Study 2			
araw	wash	unbiased	*Kinoo wa hareta. Kanachan wa kinoo te o (aratta).* It was sunny yesterday. Kana-chan washed her hands yesterday.
nom	drink	unbiased	*Kinoo wa kumotta. Kanachan wa kinoo juusu o (nonda).* It was clouded yesterday. Kana-chan drank juice

			yesterday.
nak	cry	unbiased	*Kinoo wa hareta. Kanachan wa kinoo (naita).* It was sunny yesterday. Kana-chan cried yesterday.
koware	break	unbiased	*Kinoo wa ame ga futta. Kanachan no omocha wa kinoo (kowareta).* It rained yesterday. Kana-chan's toy broke up yesterday.
hak	wear	unbiased	*Kinoo wa hareta. Kanachan wa kinoo sukaato o (haita).* It was sunny yesterday. Kana-chan wore a skirt yesterday.
odor	dance	unbiased	*Kinoo wa kumotta. Kanachan wa kinoo (odotta).* It was clouded yesterday. Kana-chan danced yesterday.
utaw	sing	unbiased	*Kinoo wa ame ga futta. Kanachan wa kinoo uta o (utatta).* It rained yesterday. Kana-chan sang a song yesterday.
ker	kick	unbiased	*Kinoo wa hareta. Kanachan wa kinoo booru o (ketta).* It was sunny yesterday. Kana-chan kicked a ball yesterday.
hik	play instruments	unbiased	*Kinoo wa kumotta. Kanachan wa kinoo gitaa o (hiita).* It was clouded yesterday. Kana-chan played the guitar yesterday.
mawas	spin	unbiased	*Kinoo wa hareta. Kanachan wa kinoo koma o (mawasita).* It was sunny yesterday. Kana-chan spinned a top yesterday.
Test sentences (Nonpast target) for both Study 1 and 2			
asob	play	nonpast>pa	*Asita wa hareru. Kanachan wa asita Hirokun to*

		st	*(asobu).* It will be sunny tomorrow. Kana-chan will play with Hiro-kun tomorrow.
chigaw	be different	nonpast>past	*Asita wa kumoru. Kanachan wa asita kutu ga (tigau).* It will be clouded tomorrow. Kana-chan's shoes will be different tomorrow.
kak	write	nonpast>past	*Asita wa ame ga furu. Kanachan wa asita ji o (kaku).* It will rain tomorrow. Kana-chan will write letters tomorrow.
kir	cut	nonpast>past	*Asita wa hareru. Kanachan wa asita kami o (kiru).* It will be sunny tomorrow. Kana-chan will cut papers tomorrow.
sagas	look for	nonpast>past	*Asita wa samuku naru. Kanachan wa asita omocha o (sagasu).* It will become cold tomorrow. Kana-chan will look for her toy tomorrow.
suwar	sit	nonpast>past	*Asita wa hareru. Kanachan wa asita aoi isu ni (suwaru).* It will be sunny tomorrow. Kana-chan will sit on a blue chair tomorrow.
yom	read	nonpast>past	*Asita wa ame ga furu. Kanachan wa asita ehon o (yomu).* It will rain tomorrow. Kana-chan will read a picture book tomorrow.
ire	put into	nonpast>past	*Asita wa kumoru. Kanachan wa asita omocha o hako ni (ireru).* It will be clouded tomorrow. Kana-chan will put her toy in the box tomorrow.
ne	sleep	nonpast>past	*Asita wa samuku naru. Kanachan wa asita okaasan to (neru).*

			It will become cold tomorrow. Kana-chan will sleep with her mother tomorrow.
tukaw	use	nonpast>past	*Asita wa hareru. Kanachan wa asita ohasi o (tukau).* It will be sunny tomorrow. Kana-chan will use chopsticks tomorrow.
moraw	receive	past>nonpast	*Asita wa hareru. Kanachan wa asita okasi o (morau).* It will be sunny tomorrow. Kana-chan will be given sweets tomorrow.
naor	get well	past>nonpast	*Asita wa atatakaku naru. Kanachan wa asita kaze ga (naoru).* It will become warm tomorrow. Kana-chan will recover from a cold quickly tomorrow.
owar	end	past>nonpast	*Asita wa hareru. Kanachan no yorugohan wa asita roku ji ni (owaru).* It will be sunny tomorrow. Kana-chan's dinner will end at 6 tomorrow.
suk	become empty	past>nonpast	*Asita wa ame ga furu. Kanachan wa asita onaka ga (suku).* It will rain tomorrow. Kana-chan will become hungry tomorrow.
tuk	arrive	past>nonpast	*Asita wa ame ga furu. Kanachan wa asita eki ni (tuku).* It will rain tomorrow. Kana-chan will arrive at the station tomorrow.
mituke	find	past>nonpast	*Asita wa kumoru. Kanachan wa asita booru o (mitukeru).* It will be clouded tomorrow. Kana-chan will find a ball tomorrow.
ochi	fall	past>nonpast	*Asita wa atatakaku naru. Kanachan no koppu wa asita (otiru).* It will become warm tomorrow. Kana-chan's mug

			will fall down tomorrow.
tukamae	catch	past>nonpast	*Asita wa kumoru. Kanachan wa asita choocho o (tukamaeru).* It will be clouded tomorrow. Kana-chan will catch a butterfly tomorrow.
fum	tread	past>nonpast	*Asita wa hareru. Kanachan wa asita isi o (fumu).* It will be sunny tomorrow. Kana-chan will tread on a stone tomorrow.
kie	disappear	past>nonpast	*Asita wa kumoru. Kanachan no oyatu ga asita (kieru).* It will be clouded tomorrow. Kana-chan's cake will disappear tomorrow.
Test sentences (Past target) for both Study 1 and 2			
asob	play	nonpast>past	*Kinoo wa hareta. Kanachan wa kinoo Hirokun to (asonda).* It was sunny yesterday. Kana-chan played with Hiro-kun yesterday.
chigaw	be different	nonpast>past	*Kinoo wa kumotta. Kanachan wa kinoo kutu ga (tigatta).* It was clouded yesterday. Kana-chan's shoes were different yesterday.
kak	write	nonpast>past	*Kinoo wa ame ga futta. Kanachan wa kinoo ji o (kaita).* It rained yesterday. Kana-chan wrote letters yeterday.
kir	cut	nonpast>past	*Kinoo wa hareta. Kanachan wa kinoo kami o (kitta).* It was sunny yesterday. Kana-chan cut papers yesterday.
sagas	look for	nonpast>past	*Kinoo wa samuku natta. Kanachan wa kinoo omocha o (sagasita).* It became cold yesterday. Kana-chan looked for her toy yesterday.

suwar	sit	nonpast>past	*Kinoo wa hareta. Kanachan wa kinoo aoi isu ni (suwatta).* It was sunny yesterday. Kana-chan sat on a blue chair yesterday.
yom	read	nonpast>past	*Kinoo wa ame ga futta. Kanachan wa kinoo ehon o (yonda).* It rained yesterday. Kana-chan read a picture book yesterday.
ire	put into	nonpast>past	*Kinoo wa kumotta. Kanachan wa kinoo omocha o hako ni (ireta).* It was clouded yesterday. Kana-chan put her toy in the box yesterday.
ne	sleep	nonpast>past	*Kinoo wa samuku natta. Kanachan wa kinoo okaasan to (neta).* It became cold yesterday. Kana-chan slept with her mother yesterday.
tukaw	use	nonpast>past	*Kinoo wa hareta. Kanachan wa kinoo ohasi o (tukatta).* It was sunny yesterday. Kana-chan used chopsticks yesterday.
moraw	receive	past>nonpast	*Kinoo wa hareta. Kanachan wa kinoo okasi o (moratta).* It was sunny yesterday. Kana-chan was given sweets yesterday.
naor	get well	past>nonpast	*Kinoo wa atatakaku natta. Kanachan wa kinoo kaze ga (naotta).* It became warm yesterday. Kana-chan recovered from a cold quickly yesterday.
owar	end	past>nonpast	*Kinoo wa hareta. Kanachan no yorugohan wa kinoo roku ji ni (owatta).* It was sunny yesterday. Kana-chan's dinner finished at 6 yesterday.
suk	become	past>nonpa	*Kinoo wa ame ga futta. Kanachan wa kinoo*

	empty	st	*onaka ga (suita).* It rained yesterday. Kana-chan became hungry yesterday.
tuk	arrive	past>nonpast	*Kinoo wa ame ga futta. Kanachan wa kinoo eki ni (tuita).* It rained yesterday. Kana-chan arrived at the station yesterday.
mituke	find	past>nonpast	*Kinoo wa kumotta. Kanachan wa kinoo booru o (mituketa).* It was clouded yesterday. Kana-chan found a ball yesterday.
ochi	fall	past>nonpast	*Kinoo wa atatakaku natta. Kanachan no koppu wa kinoo (otita).* It became warm yesterday. Kana-chan's mug fell down yesterday.
tukamae	catch	past>nonpast	*Kinoo wa kumotta. Kanachan wa kinoo choocho o (tukamaeta).* It was clouded yesterday. Kana-chan catched a butterfly yesterday.
fum	tread	past>nonpast	*Kinoo wa hareta. Kanachan wa kinoo isi o (funda).* It was sunny yesterday. Kana-chan trod on a stone yesterday.
kie	disappear	past>nonpast	*Kinoo wa kumotta. Kanachan no oyatu ga kinoo (kieta).* It was clouded yesterday. Kana-chan's cake disappeared yesterday.

Appendix B. Complete set of test sentences used in the Study 1 of Chapter 7.

Warm up sentences for children				
N.	verb	meaning	bias	test sentence and English translation
w1	*tabe*	eat	unbiased	*Kinoo Yuuchan wa keeki o (tabeta / tabeteta).* Yesterday Yuuchan was eating a cake.
w2	*kam*	bite	unbiased	*Kinoo Yuuchan wa gamu o (kanda / kandeta).* Yesterday Yuuchan chewed a gum.
Test sentences for children				
C1	*araw*	wash	simple>stative	*Kinoo Yuuchan wa te o (aratta / aratteta).* Yesterday Yuuchan was washing her hands.
C2	*fum*	step on	simple>stative	*Kinoo Yuuchan wa isi o (funda / fundeta).* Yesterday Yuuchan was stepping on a stone.
C3	*hair*	enter	simple>stative	*Kinoo Yuuchan wa puuru ni (haitta / haitteta).* Yesterday Yuuchan was in the pool.
C4	*hippar*	pull	simple>stative	*Kinoo Yuuchan wa sippo o (hippatta / hippatteta).* Yesterday Yuuchan was pulling the tail.
C5	*taore*	fall_down	simple>stative	*Kinoo Yuuchan no kasau ga (taoreta / taoreteta).* Yesterday Yuuchan's umbrella was fallen down.
C6	*nor*	ride	simple>stative	*Kinoo Yuuchan wa densha ni (notta / notteta).* Yesterday Yuuchan was on the train.
C7	*tukamae*	catch	simple>stative	*Kinoo Yuuchan wa choucho o (tukamaeta / tukamaeteta).* Yesterday Yuuchan was catching

				butterflies.
C8	*mawar*	turn	simple>stative	*Kinoo Yuuchan no koma ga (mawatta / mawatteta).* Yesterday Yuuchan's top was spinning.
C9	*nak*	cry	simple>stative	*Kinoo Yuuchan wa sikusiku (naita / naiteta).* Yesterday Yuuchan was crying softly.
C10	*nom*	drink	simple>stative	*Kinoo Yuuchan wa gyuunyuu o (nonda / nondeta).* Yesterday Yuuchan was drinking milk.
C11	*wasure*	forget	stative>simple	*Kinoo Yuuchan wa obentoo o (wasureta / wasureteta).* Yesterday Yuuchan forgot her lunchbox.
C12	*sir*	know	stative>simple	*Kinoo Yuuchan wa anoko o (sitta / sitteta).* Yesterday Yuuchan knew that boy.
C13	*mot*	hold	stative>simple	*Kinoo Yuuchan wa booru o (motta / motteta).* Yesterday Yuuchan had a ball.
C14	*mat*	wait	stative>simple	*Kinoo Yuuchan wa papa o (matta / matteta).* Yesterday Yuuchan was waiting for her father.
C15	*hasir*	run	stative>simple	*Kinoo Yuuchan wa oniwa de (hasitta / hasitteta).* Yesterday Yuuchan was running in the garden.
C16	*nokor*	remain	stative>simple	*Kinoo Yuuchan no keeki ga (nokotta / nokotteta).* Yesterday Yuuchan's cake was left.
C17	*kabur*	put_on_hat	stative>simple	*Kinoo Yuuchan wa boosi o (kabutta / kabutteta).* Yesterday Yuuchan was wearing a hat.
C18	*hak*	wear	stative>simple	*Kinoo Yuuchan wa sukaato o (haita /*

				haiteta). Yesterday Yuuchan was wearing a skirt.
C19	*waraw*	laugh	stative>simple	*Kinoo Yuuchan wa ahaha tte (waratta / waratteta).* Yesterday Yuuchan was laughing "ahaha".
C20	*kakure*	hide	stative>simple	*Kinoo Yuuchan wa kaaten ni (kakureta / kakureteta).* Yesterday Yuuchan was hiding in the curtain.
Sentences for experimenter				
E1	*hik*	play	unbiased	*Kinoo Yuuchan wa gitaa o hiiteta.* Yesterday Yuuchan was playing the guitar.
E2	*sagas*	look for	unbiased	*Kinoo Yuuchan wa neko o sagasiteta.* Yesterday Yuuchan was looking for a cat.
E3	*odor*	dance	unbiased	*Kinoo Yuuchan wa odotteta.* Yesterday Yuuchan was dancing.
E4	*oyog*	swim	unbiased	*Kinoo Yuuchan wa umi de oyoideta.* Yesterday Yuuchan was swimming in the sea.
E5	*oki*	get up	unbiased	*Kinoo Yuuchan wa yoru okiteta.* Yesterday Yuuchan was awake at night.
E6	*asob*	play	unbiased	*Kinoo Yuuchan wa nawatobi de asobu.* Yesterday Yuuchan was playing with a skipping rope.
E7	*narab*	line up	unbiased	*Kinoo Yuuchan no kutu wa narandeta*. Yesterday Yuuchan's shoes were lined up.
E8	*ur*	sell	unbiased	*Kinoo Yuuchan wa pan o utteta.* Yesterday Yuuchan was selling bread.
E9	*tukam*	grab	unbiased	*Yuucnan wa mama no ude o tukandeta.* Yesterday Yuuchan was holding her mother by the arm.
E10	*shaber*	chat	unbiased	*Kinoo Yuuchan wa mama to shabetteta.* Yesterday Yuuchan was chatting with her

				mother.
E11	*osie*	teach	unbiased	*Kinoo Yuuchan wa hiragana o osieteta.* Yesterday Yuuchan was teaching Japanese letters.
E12	*kuttuke*	stick	unbiased	*Kinoo Yuuchan wa densha o kuttuketeta.* Yesterday Yuuchan was connecting some toy trains together.
E13	*aruk*	walk	unbiased	*Kinoo Yuuchan wa kooen de aruiteta.* Yesterday Yuuchan was walking in the park.
E14	*fur*	rainfall	unbiased	*Kinoo Yuuchan no tanjoobi wa amega futteta.* Yesterday Yuuchan's birthday was rainy.
E15	*hos*	dry	unbiased	*Kinoo Yuuchan wa sentakumono o hositeta.* Yesterday Yuuchan was hanging the washing out.
E16	*mak*	wind	unbiased	*Kinoo Yuuchan wa mafuraai o maiteta.* Yesterday Yuuchan was winding a scarf.
E17	*magar*	bend	unbiased	*Kinoo Yuuchan no supuun ga magatteta.* Yesterday Yuuchan's spoon was bent.
E18	*yorokob*	be pleased	unbiased	*Kinoo Yuuchan wa yorokondeta.* Yesterday Yuuchan was delighted.
E19	*sak*	bloom	unbiased	*Kinoo Yuuchan no ohana ga saiteta.* Yesterday Yuuchan's flower was in bloom.
E20	*ker*	kick	unbiased	*Kinoo Yuuchan wa booru o ketteta.* Yesterday Yuuchan was kicking the ball.

Appendix C. Complete set of test sentences used in the Study 2 of Chapter 7.

Warm up sentences for children				
N.	verb	meaning	bias	test sentence and English translation
W1	*nom*	drink	unbiased	*Ponchan wa juusu o (nonda / nonjatta).* Ponchan has drunken the juice.
W2	*su*	do	unbiased	*Ponchan wa geemu (sita / sichatta).* Ponchan has played video game.
Test sentences for children				
C1	*moraw*	get	simple>completive	*Ponchan wa hooki o (moratta / moratchatta).* Ponchan was given a broom.
C2	*tat*	stand	simple>completive	*Ponchan wa teeburu ni (tatta / tatchatta).* Ponchan stood on the table.
C3	*kaw*	buy	simple>completive	*Ponchan wa piiman o (katta / katchatta).* Ponchan has bought green peppers
C4	*mi*	look	simple>completive	*Ponchan wa kaminari o (mita / michatta).* Ponchan has seen a lightening.
C5	*mituke*	find	simple>completive	*Ponchan wa hebi o (mituketa / mitukechatta).* Ponchan has found a snake.
C6	*tukur*	make	simple>completive	*Ponchan wa isu o (tukutta / tukutchatta).* Ponchan has made a chair.
C7	*ire*	put in	simple>completive	*Ponchan wa kutu o (ireta / irechatta).* Ponchan has put shoes in.
C8	*tor*	take	simple>completive	*Ponchan wa kasa o (totta / totchatta).* Ponchan took an umbrella.
C9	*kak*	write	simple>completive	*Ponchan wa namae o (kaita / kaichatta).* Ponchan wrote a name.
C10	*nor*	ride	simple>completive	*Ponchan wa densha ni (notta / notchatta).* Ponchan has taken a train.
C11	*nakunar*	disappear	completive>simple	*Ponchan wa omocha ga (nakunatta / nakunatchatta).*

				Ponchan's toy has gone missing.
C12	*otos*	drop	completive>simple	*Ponchan wa osaifu o (otosita / otosichatta).* Ponchan has lost his purse.
C13	*wasure*	forget	completive>simple	*Ponchan wa kaban o (wasureta / wasurechatta).* Ponchan has forgotten his bag.
C14	*hazure*	fail	completive>simple	*Ponchan wa taiya ga (hazureta / hazurechatta).* Ponchan has got a tire come off.
C15	*koware*	break	completive>simple	*Ponchan wa tumiki ga (kowareta / kowarechatta).* Ponchan's building blocks have broken.
C16	*okkochi*	fall down	completive>simple	*Ponchan wa koppu ga (okkochita / okkochichatta).* Ponchan's glass has fallen down.
C17	*ware*	get broken	(completive>simple)	*Ponchan wa osara ga (wareta / warechatta).* Ponchan's plate has got broken.
C18	*kire*	cut	(completive>simple)	*Ponchan wa himo ga (kireta / kirechatta).* The string has broken.
C19	*nak*	cry	(completive>simple)	*Ponchan wa obake ni (naita / naichatta).* Ponchan cried with a ghost.
C20	*korob*	fall down	(completive>simple)	*Ponchan wa dooro de (koronda / koronjatta).* Ponchan fell down on the street.
Sentences for experimenter				
E1	*asob*	play	unbiased	*Ponchan wa kooen de asonjatta.* Ponchan played in a park.
E2	*chirakas*	mess up	unbiased	*Ponchan wa heya o chirakasichatta.* Ponchan has messed the room up.
E3	*muk*	peel	unbiased	*Ponchan wa mikan o muichatta.* Ponchan peeled an orange.

E4	*hare*	swell	unbiased	*Ponchan wa hoppeta ga harechatta.* Ponchan's cheek has swollen up.
E5	*fue*	increase	unbiased	*Ponchan wa gomi ga fuechatta.* Ponchan's rubbish has increased.
E6	*mazar*	mix	unbiased	*Ponchan wa iro ga mazatchatta.* Ponchan has got the colors mixed.
E7	*tomar*	stop	unbiased	*Ponchan wa tokei ga tomatchatta.* Ponchan's watch has stopped.
E8	*nemur*	sleep	unbiased	*Ponchan wa futon de nemutchatta.* Ponchan slept in the duvet.
E9	*nokor*	be left	unbiased	*Ponchan wa gohan ga nokotchatta.* Ponchan has got some rice left.
E10	*or*	bend	unbiased	*Ponchan wa eda o otchatta.* Ponchan bent a branch.
E11	*sime*	shut	unbiased	*Ponchan wa mado o simechatta.* Ponchan has shut the window.
E12	*sugi*	pass	unbiased	*Ponchan wa omise o sugichatta.* Ponchan has passed the shop.
E13	*tob*	fly	unbiased	*Ponchan wa nawatobi o tonjatta.* Ponchan skipped rope.
E14	*tukaw*	use	unbiased	*Ponchan wa hasami o tukatchatta.* Ponchan used scissors.
E15	*yabur*	tear	unbiased	*Ponchan wa kami o yabutchatta.* Ponchan has teared papers.
E16	*yuzur*	cede	unbiased	*Ponchan wa seki o yuzutchatta.* Ponchan ceded a seat.
E17	*agar*	ascend	unbiased	*Ponchan wa kaidan o agatchatta.* Ponchan has gone up the stairs.
E18	*nug*	take off	unbiased	*Ponchan wa fuku o nuijatta.* Ponchan has taken his clothes off.
E19	*okor*	get angry	unbiased	*Ponchan wa itazura de okotchatta.* Ponchan got angry at mischief.
	watas	give	unbiased	*Ponchan wa ehon o watasichatta.*

E20				Ponchan gave a picture book.

Appendix D. Sample parental consent form and information sheet (from Chapter 7)

These forms were translated in Japanese and used.

UNIVERSITY OF LIVERPOOL

Testing Nativist and Constructivist Models of Morphological Development using Japanese

Parent information sheet

Dear Parent,

I would like to invite your child to participate in a scientific study. The Headteacher of the nursery has been kind enough to let us conduct one of our studies with children at the nursery. Before deciding whether you would like your child to participate in this study, it is important to understand why and how the study will be conducted. Please read through the information slowly and carefully. If you would like more information or have any questions, please do not hesitate to ask the researcher, or discuss the study with the nursery staff. I would like to stress that you and your child do not have to agree to participate in this study and should agree to do so only if you would like to be involved in it.

About the study

How people acquire language is one of the main questions in psychology. For a long time the prevailing theory was that children are born with a fairly good understanding about grammar (e.g. they have a rough idea what a verb is and that it comes with a noun); they are just waiting to learn enough words and their meanings. More recent studies have shown, however, that children often make mistakes that do not support this idea and some scientists have suggested that we learn a language word-by-word, phrase-by-phrase. One of the main problems with these theories is that most of the research is done in English, even though some parts of the English grammar are quite simple compared with other languages. Japanese, on the other hand, has a very complicated grammatical system and is ideal for doing such research.

If you decide to allow your child to participate in this study, she/he will be shown several pictures and I will ask him/her to complete some sentences relating to the picture (e.g. "Ken ___ to the park tomorrow."). The sentences will be said in a way that encourages the child to use different forms of the verb.

Ethics, anonymity and confidentiality

Children will work with the researcher in a quiet area of the nursery that can be seen by the class teacher and/or the other children. The researcher has previous experience of working with children and the study procedure has been approved by her PhD project supervisors and the University of Liverpool Research Ethics Committee.

The data will be anonymous; only the researchers involved will have access to the data; and the children's names will not be kept with the data. In the write-up of the research, the data will also be presented completely anonymously: the name of the nursery will not be used, or it will be changed; results for individual children will not be discussed. The nursery will also be sent a summary of the results of the study, but without mentioning of the results for any individual child.

Please note that this study will not and cannot test any particular child's language skills. This research is looking at children's understanding of grammar in general.

If you WOULD like your child to take part in this study, please sign and return the attached consent form BEFORE DATE (APPROX 1 WEEK) WHEN THE STUDY WILL BEGIN.

Participation is entirely voluntary and you may withdraw your child at any time without having to give a reason (if you withdraw your child after the study has begun, we will destroy any data already collected, unless the project write-up has already been submitted for publication by). If an individual child does not want to participate, she/he will not be asked to do so, even if you have given consent for your child to participate.

Reporting complaints and adverse effects

The study has been approved by the University of Liverpool Research Ethics Committee. However, if you are unhappy, or think there is a problem with the study, please contact the principal investigators **Prof Julian Pine (jpine@liverpool.ac.uk) or Dr Ben Ambridge (ambridge@liverpool.ac.uk)**. If you remain unhappy or have a complaint which you feel you cannot come to us with, then you should contact the **Research Governance Officer on +44 151 794 8290 (ethics@liv.ac.uk)**. When contacting the Research Governance Officer, please provide details of the name or description of the study (Testing Nativist and Constructivist Models of Morphological Development using Japanese), the researchers involved, and the details of the complaint you wish to make.

Contact Details

If you would like further information on this study, have any questions, or would like to view the pictures before you make a decision, please do not hesitate to contact me **(email: ttomoco@hotmail.co.jp)**. Further details about the research of the Centre can be found at www.liv.ac.uk/psychology-health-and-society.

Thank you for your attention,

Tomoko Tatsumi

UNIVERSITY OF LIVERPOOL

CONSENT FORM

Testing Nativist and Constructivist Models of Morphological Development using Japanese

Researcher: Tomoko Tatsumi

1. I confirm that I have read and understood the information sheet (date:) for the above study. I have been given enough time to consider the information and my questions have been answered to my satisfaction. ☐
2. I understand that my child's participation in this study is voluntary and that I may withdraw her/him from the study at any time, without providing the reason and without her/his rights being affected. ☐
3. I understand that I can request access to my child's data and its destruction, unless the research has already been submitted for the publication. ☐
4. I understand that the data collected is **anonymous and confidential**. My child's identity will not be identifiable. Only researchers in the language acquisition group at the University of Liverpool will be able to access the raw data. ☐
5. I agree to my child ( ) participating in the study. ☐

_____

Child's Name

_____ _____ _____

Parent's Name Date Signature

_____ _____ _____

Researcher Date Signature