SYNTACTIC BOOTSTRAPPING IN THE ADJECTIVAL DOMAIN: LEARNING SUBJECTIVE ADJECTIVES

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ABSTRACT OF THE DISSERTATION

Syntactic Bootstrapping in the Adjectival Domain: Learning Subjective Adjectives

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How do children learn the meaning of words like "pretty" and "tall," which are not only gradable and context dependent (Kennedy & McNally 2005), but encode speaker subjectivity? Despite their complex semantics (Stephenson 2007; Lasersohn 2009; Bylinina 2014), these and other adjectives like them, are some of the most frequently produced adjectives by children and their caregivers. How do children map the right meaning to these adjectives early in language acquisition?

In this dissertation, I present the results of a corpus-based analysis of ambient language, and a word learning experiment using an adapted human simulation paradigm (Gillette et al. 1999) with scripted dialogues (Yuan & Fisher 2009; Arunachalam & Waxman 2010) demonstrating the influence of the syntactic environment in which these adjectives appear. Although previous literature has extensively explored syntactic bootstrapping in the verbal domain (Landau & Gleitman 1985; Gleitman 1990; among many others), few researchers have extended it to adjectives (Syrett & Lidz 2010; Becker 2015). Here I push this framework further within the adjectival domain, investigating it through the lens of subjective adjectives. I focus on five subclasses (TOUGH, SMART, PRETTY, TASTY, TALL). While they share overlapping properties, each is distinguished by a unique syntactic signature.

Corpus results indicate distributional differences among adjectival subcategories, indicating that they pattern in predictable ways in the input. In the word learning experiment,

participants were presented with a set of syntactic frames, with each set corresponding to one of the five classes, and asked to provide the meaning for a novel adjective along with their confidence level. Participants either responded incrementally after each frame or after all of the frames had been presented. They not only displayed an awareness of how syntactic frames narrowed the potential meaning for each adjective, but participants in the incremental conditions performed significantly better than those in the conditions in which they guessed after the frame set, and became more confident as they received more frames.

Based on these results, I propose that adjectival (sub-)categories are assigned probabilities that shift as a function of data encountered that is either consistent or inconsistent with a particular categorization (Reiger & Gahl 2004; Yang 2002). Frames are weighted according to their relative informativity. As learners encounter more frames, they gradually update their hypothesis space, and ultimately assess the entire cluster of frames, consistent with previous proposals by (Naigles 1996; Mintz 2003) for verbs.

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CHAPTER 1
INTRODUCTION

1.1 Introduction

In order to better understand how children acquire language, it is necessary to address how they map concepts and meanings to individual words. An influential theory about word learning in language acquisition is Syntactic Bootstrapping (Landau & Gleitman 1985; Gleitman 1990), which proposes that children rely on the syntactic environment in which a word is found to inform them of its meaning. In the previous literature on Syntactic Bootstrapping, the focus has been on verb learning, and how it may be extended to different types of verbal predicates. Other grammatical categories, particularly adjectives, have not been emphasized to the same degree.

This dissertation is an extension of the bootstrapping literature in the adjectival domain. In this research, I examine subjective adjectives (e.g. *fun, easy, delicious, good, big*) as a case study. These adjectives are of interest because they are exactly the type of predicate that inspired Landau & Gleitman (1985) when originally formulating their claim for two reasons: (i) they correspond to properties that have no visual correlate, and (ii) they correspond to properties without a stable referent. For example, it is not possible to point to what *delicious* means, and what is *delicious* or *fun* for one speaker is *disgusting* or *boring* to another. While learners are unable to rely on observation to learn these words, it is reasonable to suspect that they may be recruiting syntactic information to determine what these words mean, if adjective learning parallels verb learning. The objective of this dissertation is thus to determine to what extent syntactic information guides learners when acquiring subjective adjectives, and to answer two fundamental questions: Are children encountering subjective adjectives in the exposure language in particular syntactic environments that would support

learning, and facilitate bootstrapping? And are learners sensitive to this information, such that they actively recruit this syntactic information when acquiring novel adjectives?

In order to address these questions, in Chapter 2, I first discuss previous research on syntactic bootstrapping and how it has been applied to the nominal and verbal domains in particular, before discussing what has been done thus far on adjective learning. I review representative studies that have illustrated that children are sensitive to the syntactic environment or specific frame in which a word is found. The reason that syntactic bootstrapping is such a powerful tool in learning is because it is able to exploit certain "expectations" provided by the grammar. For example, certain verbs select for arguments, and others do not; finding a verb with an argument informs the child that this is a transitive verb, and they are able to match arguments to particular thematic roles. This knowledge of selectional properties is part of Universal Grammar (UG), and children are able to use this knowledge of the grammar to guide them as they encounter novel words in specific syntactic environments known as frames (Gleitman 1990). As will be discussed in this chapter, beyond the number of arguments, children exhibit an awareness of a variety of (morpho)-syntactic distinctions, which indicates an awareness of structural properties. Syntactic bootstrapping differs from other theories concerning distributional cues and statistical learning, which assume that children extract information from surface-level strings based on patterns alone (see Saffran 2002), because it assumes that UG provides scaffolding for analyzing the input. In other words, children recruit their knowledge of frames to map words to meanings.

In this dissertation, I adopt the assumption from the bootstrapping literature that UG provides a foundation for the child to rely on while forming syntax-semantic mappings, and that it is for precisely this reason that syntactic frames are informative. I connect the previous research on bootstrapping with nouns and verbs to (subjective) adjectives in order to draw a parallel in the learning process. If syntactic bootstrapping is a general word learning mechanism, this implies that just as frames help children to learn different nouns and verbs, equally informative frames should help them to learn adjectives. Just as nouns

and verbs have selectional properties, so too do adjectives. Syntactic bootstrapping at its core is also a claim that emphasizes syntax to the exclusion of other types of information during the word learning process. I argue that limited prior research on adjective learning considers the confluence of syntactic and semantic cues, as opposed to the contribution of the syntax alone. In the following chapters, I ask if there are syntactic frames that children recruit to learn the meanings of novel adjectives, and address what the learner is able to deduce from these frames alone. In other words, how much influence does the syntax have on the learner? This question forms the basis for both corpus and experimental research presented later in the dissertation.

For there to be syntactic frames associated with subjective adjectives, there needs to be information that would tease these adjectives apart them all others. In Chapter 3, I review the syntactic and semantic literature on subjective adjectives, and establish the criteria that I use to classify adjectives as subjective. After determining that an adjective is subjective, it is able to be further subdivided into particular classes. Here I focus on five classes of subjective adjectives in particular, which I refer to in terms of a representative member of that class: TOUGH, SMART, PRETTY, TASTY and TALL. These classes are motivated based on particular well-known properties that these adjectives exhibit. I show that while each class has properties that overlap with other classes, each class nonetheless has a unique set of properties that forms a signature for its classification.

In Chapter 4, I detail a corpus-based analysis that is a response to the first question that motivated this research, concerning the availability of syntactic information that highlights subjective adjectives and their syntactic environments. I present results from a search of 44 corpora from the Child Language Data Exchange System (CHILDES), in which I document the individual adjectives that children encounter, but also classify these adjectives by subcategory. I provide an analysis of the syntactic environments in which these adjectives are found. In doing so, I illustrate that there are particular environments that are associated with particular classes, specifically the type of pre-adjectival modifier and the type of

clause that is found after the adjective.

In Chapter 5, I follow up on the results from the corpora research by presenting a word learning experiment based on the Human Simulation Paradigm, in which adult learners are tasked with determining the meaning of a novel adjective given syntactic information alone. This experiment thus addresses the second question, concerning learners' sensitivity to the syntax. Participants encountered the novel adjective in a set of syntactic frames that I chose based on the signatures for each adjective class introduced earlier in Chapter 3. The results indicated that learners are able to narrow down the potential meaning of an adjective given the set of frames. By investigating if learning is facilitated by receiving each frame individually or all frames at once, I additionally found a significant difference in performance given the former mode of presentation, which I argue indicates that learners benefit from being able to incorporate information over time and revise their interpretations as more information becomes available to them. In support of this finding, I also find that these participants become more confident in their guesses as they receive more frames.

Lastly, in Chapter 6, I propose a UG + Stats approach to learning subjective adjectives. I argue that the process of acquiring these adjectives is best captured via a Bayesian learning model, in which learners incrementally update their hypothesis space for the meaning of a given adjective based on the likelihood that a frame converges with a particular interpretation. I argue that each syntactic frame is associated with a conditional probability, based on its ability to pick out a particular adjective class. The more unique a frame is, the greater the probability that it identifies one class. Conversely, frames that are compatible with multiple adjective categories are associated with lower probabilities. I schematize a model in which all adjective classes are assigned prior probabilities, and are evaluated based on data in the input. I suggest several factors that should ultimately be factored into this model, including the relative frequency of frames, cross-linguistic considerations, and the scaffolding provided by UG. By arguing for a model of learning that operates across clusters of frames, I build on previous studies in the verb-learning domain arguing for the importance

of multiple frames. I end by discussing how my research informs previous interpretations of children's early difficulties with certain adjectives, namely *tough*-adjectives, which are traditionally analyzed as raising predicates. While the previous studies in the acquisition literature have argued that children have non-adult-like syntax at an early stage in development, I claim that an alternative interpretation is that children are highly conservative and will only diverge from their baseline (non-raising) interpretation if given enough information that causes them to reanalyze how these adjectives are classified, again given the probability that a set of frames either converges with a particular hypothesis or not. I suggest that future research on the range of syntactic information available to the learner will enable us to continue to better understand and represent how adjectives, subjective or otherwise, are acquired.

CHAPTER 2
SYNTACTIC BOOTSTRAPPING

During the word learning process, children need to be able to map meaning to structure, and to form conceptual categories. In order to know what a word means, a child must determine how it is used, and what category (e.g., noun, verb) and subcategory (e.g., mass noun, count noun) the word belongs to. An ongoing question in language acquisition is how the child is able to do this– what enables this mapping? The process of word learning becomes increasingly more complicated when we consider how the child needs to learn words that refer to concrete, physical objects (like *ball, puppy*) and discernible actions (*hug, kick*), but also abstract predicates (*think, seem*) and hard-to-define concepts (like *fun, dangerous*). While it may be plausible to think that the child could learn a term like *ball* by having a parent or caretaker say, *Look! This is a ball!* it is clear that this method would only get us so far; the child is not going to encounter, *Look! This is seeming!* Moreover, even "concrete" terms are deceptively difficult when all that the child needs to consider upon hearing these terms is taken into account. As the now classic Gavagai problem from Quine (1960) illustrates, a novel word in a given context could be referring to any number of things, including entities, actions, and properties. Quine argued that if someone were to hear a word like *gavagai* in the context of seeing a rabbit, there is nothing that tells him a priori that the word refers to that animal. The word could mean 'rabbit', but it could also mean 'animal' or 'a collection of rabbit parts' or it could refer to the color of the rabbit, or to the action that the rabbit is engaged in. In fact, a novel word could even be referring to something that is not visible at all.

To expand upon the Gavagai problem, even in a situation in which there is an observable event, with an easily discernible action, the child still needs to be able to correctly identify individual words within the discourse. Imagine that the child is playing outside

and someone says, *Look! The girl is throwing a red ball!* In this context, the child has to learn that *the girl* and *ball* are nouns that pick out event participants, that *the girl* is the agent and *the ball* is the patient, that *throw* is a verb, and picks out an action taking both of the NPs as arguments, and that *red* is an adjective, which denotes a property of *the ball*, in this case a color. In other words, in order to understand the meanings of individual words, the child needs to be able to appropriately categorize individuals, events and properties, and their role (e.g. agent, patient) and relation to one another. In this context, the child could arguably be guided by tracking information that is in the visual scene. However, it quickly becomes apparent that this strategy of observation is not sufficient to explain the learning process. If the child hears, *The girl cannot find the red ball!* the usefulness of the visual scene changes. This time there is still an action, with participants, and an adjective describing one of the event participants, but (assuming a scenario where there is no red ball), there is no visual correlate in this context for the adjective.

Rather than rely on visual information, which is underinformative, it has been claimed that children depend on structural information to learn the meanings of novel words. This claim is known as Syntactic Bootstrapping (Landau & Gleitman 1985; Gleitman 1990). The motivation for this claim is based in part on the fact that (i) abstract concepts lack visual correlates, and yet children still learn these successfully, and (ii) there is a distributional signature that is associated with words that belong to the same category or sub-category that corresponds to its meaning. For example, although a verb like *know* cannot be depicted, it is often found before a tensed clause (*know that X is Y*). Children have been shown to be sensitive to this kind of distributional information (Gillette et al. 1999; Gleitman 1990; Gleitman et al. 2005). They are able to track where a word is located in the structure or, in other words, the "frame" that it is found in to determine something about its meaning. This ability has been exemplified through numerous studies over the years that have sought to explore the strength and validity of the syntactic bootstrapping hypothesis. In this section, I will review how syntactic bootstrapping has been applied to verb and noun learning, which

have received most of the attention in the literature, before moving on to what we know about adjective learning.

2.1 Case Study: Nouns

When children are in the process of building their early lexicons, some of the earliest words that they acquire are nouns. Nouns denote individuals, which means that children need to map object concepts to NPs. They need to be able to identify nouns in the discourse, and distinguish nouns from verbs and other parts of speech. However, not all nouns denote the same kinds of concepts. For example, there are both count nouns and mass nouns, with this separation indicating an ontological difference; the former refers to discrete, countable objects, whereas the latter refer to substances. Children are sensitive to this distinction early on in development, even before they produce their first words (see e.g. Soja et al. 1991; Soja 1994; Spelke & Van der Walle 1993; Huntley-Fenner, Carey & Solimando 2002; among others). They have certain expectations for how objects behave, but nevertheless need to determine how objects are categorized and labeled in the language they are learning. Researchers have found that children recruit syntactic cues in order to identify and categorize nouns along these lines.

One of the earliest studies that explored the influence of syntactic cues on noun learning comes from Brown (1957). He conducted a study with children (n=16) aged 3-4 years, in which he showed them pictures that featured people with an unfamiliar object or substance, engaging in an action. They would hear a novel word (e.g. *sib*) in a frame that corresponded to either count noun syntax, mass noun syntax, or was consistent with a verb. They were then given a set of three pictures: one featuring the same type of object (but of a different size/shape/color), one featuring the same type of substance in a different color, and one featuring an action. Children were prompted to point to the picture with e.g. another sib (count), some sib (mass) or sibbing (verb). Most children responded appropriately, based on the frame provided; 10 of 16 successfully interpreted the novel word as referring to an

action when it was presented in a verbal frame, 11 of 16 when an object when provided with count syntax, and 12 of 16 when a substance when provided with mass syntax. Brown interpreted this result as evidence that syntax forced their interpretation, given that everything remained constant except for the frame provided. See similar findings in Katz, Baker & MacNamara (1974).

Similar studies have since been conducted. Soja, Carey & Spelke (1991) conducted several word learning experiments with 2-year-old children, in which they sought to examine children's ability to extend novel word meanings to new contexts, and to investigate the role of syntax. In these tasks, children were presented with either an unfamiliar object or substance, during which time they heard the object/substance labeled with either "neutral" syntax or informative syntax (count or mass syntax). They were then presented with an object in the same shape as the exemplar, but made with a different material, or with a substance made with the same material as the exemplar, but in a different shape and in pieces. Soja, Carey & Spelke report that children who were given informative syntactic frames did not perform differently from those who were given neutral syntactic frames. Both groups were better at extending the meaning of novel objects, picking out another object with the same shape. However, it should be noted that the extent to which the neutral frames are truly neutral is unclear; the neutral frames featured *this/the/my* before the novel noun, but as the researchers admit, if the child knows something about count/mass syntax, if they hear e.g. *this is my stad* when presented with a substance, they will infer that the noun refers to the substance due to the lack of plural morphology.

Soja (1992) conducted a follow up study, also with 2-year-old children, in which she further manipulated the syntactic information. Soja implemented the same experimental design as before, but this time children were provided with "mismatching" syntax. That is, children were presented with objects but given mass noun frames, and substances with count noun frames. The conflicting syntactic information had an effect on children's performance, particularly when it was a substance with a count noun frame; children were

more likely to select an object in the same shape, and not the same substance. Importantly, Soja also found a correlation between those children who showed no sensitivity to syntax and those with little "productive control" (that is, had difficulties with count/mass syntax in terms of production and comprehension, as measured separately, with familiar words). This suggests that syntax becomes increasingly more informative for the child across development, and that children need to first learn which cues are associated with a given (sub)category. Syntax supports learning, but only if the syntax is recruited.

Additional support for syntactic bootstrapping in the nominal domain comes from cross-linguistic differences in children's performance in word learning tasks. Not all languages make the same kinds of ontological distinctions, or have the same kinds of contrasts between objects and substances expressed in the morphosyntax. Given this, it may be expected that the language children are learning may have an influence on word learning, and their ability to categorize nouns. This is what has been found in the literature. For example, Japanese does not make a count-mass distinction; although Japanese children are capable from distinguishing objects from substances, Imai & Gentner (1997) found that children perform at chance level when provided with an unfamiliar object and later asked to point to another one (when provided with two sets: an object of the same shape but of different material, and piles of the same material, different shape). Imai & Gentner argue that because Japanese does not provide any syntactic cues as to how novel nouns should be characterized, this is responsible for their performance. Similarly, Hebrew-speaking children are delayed in acquiring the count-mass distinction– a distinction that Hebrew does make (like English, but unlike Japanese)– which Hacohen & Schaeffer (2016) attribute to the relative scarcity of helpful morphosyntactic cues in Hebrew for children to rely on. For example, there is no indefinite article in Hebrew, and so this cue for count nouns is absent. In order for children to rely on syntactic information, there need to be distributional cues that are available; otherwise, the syntax is not informative.

This is one example of how syntax guides word-learning, and guides the acquisition

of nouns in particular; cues in the morphosyntax alert the child that a word is a (count or mass) noun. In turn, children are also able to rely on nouns to acquire other words, such as verbs. For this reason, there is often a "noun advantage" reported for early word learning, at least in English (Bornstein et al. 2004); nouns are acquired earlier and are produced more often than other grammatical categories (Piccin & Waxman 2004; see also discussion in Waxman & Lidz 2006).

2.2 Case Study: Verbs

Nouns support, and in a sense anchor, verb learning (Fisher 1994; Gillette et al. 1999; Gleitman 1990; among many others). This is based on the observation that the number and the position of the arguments in a sentence is informative as to the meaning of the verb. For example, because transitive verbs require both an agent and a patient, a learner who hears *the boy GORPS the ball* is likely to interpret *gorps* as meaning *throw* or *kick*, but not sleep or *laughs*. The nouns *the boy, the ball* are thus the syntactic cues that enable subcategorization. In other words, finding a verb in a particular frame reveals information about its meaning. In this section, I discuss the ways in which syntactic bootstrapping has been applied to verb learning. Syntactic bootstrapping of verbs has received considerable attention in the literature, but I will focus on three main areas of research: the acquisition of transitive and intransitive verbs, verbs that select for clausal complements, and raising verbs.

Syntactic bootstrapping in its original formulation was in fact a proposal about how children could learn verbs, specifically transitive and intransitive verbs. It was in part inspired by a study by Landau & Gleitman (1985) that examined blind children's acquisition of perception terms; Landau & Gleitman argued that visual information could not assist these children, but that their vocabulary development was not delayed. Moreover, verbs like *look* and *see* were not always used by caretakers in a situational context that explains their distribution, i.e. using *look* in contexts in which an object could be manually examined–

ruling out the possibility that there is a pattern to when these words can be used. However, Landau & Gleitman (1985) argue that there is reliable information that can be recruited to learn these terms, namely the subcategorization frames in which these verbs are found. For example, a verb like *see* would be often used with an object.

Much of the early research on verb learning has extended the observations from Landau & Gleitman (1985) by examining the usefulness of these frames in various word learning tasks. To this end, several experiments have examined if children are capable of learning novel verbs when given informative frames. Naigles (1990) conducted a study with 2-year-old children using the preferential looking paradigm, in which they watched videos while hearing a novel verb (*gorping*) in a particular frame, either a transitive or intransitive one. They then saw two separate videos simultaneously, and were prompted to find *gorping*. Children looked longer at the video that depicted an action that corresponded to the frame that they had been given. For example, those that heard *the rabbit is gorping the duck* looked at the video where the rabbit pushed the duck, and those that heard *the rabbit and the duck are gorping* looked longer at the video of the rabbit and the duck waving their arms. In this task, all of the frames featured two arguments and a nonsense verb; the only difference is the position of the arguments. This demonstrates that children are not only tracking arguments, but are also importantly tracking the position of those arguments in order to deduce meaning.

Yuan, Fisher & Snedeker (2012) conducted a similar study with infants (21 months), who saw two videos simultaneously, one with two people performing an action together (one as the agent, the other as the patient), and another with a single person performing an action. Children heard a novel verb used in a particular frame. In this study, however, the infant would hear the verb with or without an object. They found that children attended to the video with two people performing an action together when given a transitive frame with an object. Children are thus paying attention to the number of arguments, and are sensitive to the presence (or absence) of syntactic cues.

The previous studies illustrate that children, when given a frame, are able to map a given action to that frame. These are essentially forced choice tasks, since the child presumably understands that one of the two options corresponds to the frame provided. Children are also able to generate potential meanings when given novel verbs as well. Fisher et al. (1989) conducted a study with 4-year-olds in which they prompted children to guess the meanings of the novel verbs. Children saw videos of animals engaged in some action that was able to be described in two different ways, depending on the perspective, e.g. feeding vs. eating. A puppet would describe the scene using a frame that would support a particular interpretation, such as *the elephant moaks the rabbit* (feeding) or *the rabbit moaks* (eating). The child would then guess what *moak* means. Unlike in the other studies, children were also provided with transitive frames in which the meaning of the verb depended on which argument is interpreted as the subject. For example, a scene in which a rabbit is running after a skunk could be described with either *chasing* or *fleeing* – but if the rabbit is the one running after the skunk and *the rabbit* is the agent of the verb in subject position (e.g., *the rabbit ZARPS the skunk*), the verb is interpreted as *chases*. The reverse is true if *the skunk* is the agent of the verb, in subject position– this same verb would now be interpreted as *flees*. Independently, it has been argued that children have expectations for the alignment of arguments; agents are assumed to be subjects, and patients are assumed to be patients (see Hyams et al. 2006). If children are relying on the frame, and paying attention to the relationship between arguments, then children are expected to be able to make these subtle distinctions in meaning. Fisher et al. (1989) found that children provided guesses that were consistent with the frames about 85% of the time, indicating that children were being guided by the syntax.

Additionally, not only are children paying attention to individual frames, they are also tracking verbs across multiple frames (Naigles 1996; Mintz 2003). For example, Naigles (1996) conducted a study to see if children could rely on distributional information to learn causative verbs. Children watched pairs of videos of animals performing some action,

and would hear a causative verb in either a transitive or an unaccusative frame, as well as (non-causative) transitive verbs that drop an argument.

(1) a. The girl dropped the ball.
b. The ball dropped.

(2) a. The cat was scratching the door.
b. The cat was scratching.

Naigles predicted that if children are tracking the position of the nouns, then the alternation in (1) would be useful in learning causative verbs. She found that children who were given pairs of frames, with the causative alternation, looked at the video depicting the causative action. This was also the baseline preference. Conversely, children who were given the other set of frames (2), with the omitted objects, did not have a preference for the video depicting the causative action or the non-causative action. This suggests that children are considering information beyond the immediate syntactic environment when determining the meaning of a given verb, otherwise they should interpret the verbs in the same way since they both take a subject and an object. Similarly, Bunger & Lidz (2004) also found that children were able to recruit information from across frames to distinguish how a verb is behaving. Bunger & Lidz presented children with videos depicting either the means of the causative event, or the result of the causative event. Children attended significantly longer to the result when given an unaccusative frame or when given multiple frames (both the transitive and unaccusative frames). They interpreted their results as not only confirming that children are sensitive to syntactic information, but also indicating that they are able to tease apart events in terms of perspective– both frames describe the same event, but the focus is either on the agent or the patient. The findings here are important because they complement the earlier studies, indicating that children are capable of making fine-grained distinctions.

Most of the earlier studies on syntactic bootstrapping in the verbal domain have focused on nouns as syntactic cues, specifically the number of arguments. However, more recent studies have sought to explore how syntactic bootstrapping is able to be extended beyond transitive and intransitive verbs, and what other syntactic cues children may be able to recruit to map meanings. As previously mentioned, syntactic bootstrapping had originally been proposed due to the fact that observation alone is insufficient to support word learning, even in contexts in which there is visual information available. However, with verbs like *kick* or *jump*, there is still a visual correlate, and this information could still be helping the child, providing extra-linguistic support that supplements the syntactic frame. Not all verbs have a visual correlate, however. Attitude (or mental-state) verbs like *think*, *know* or *wonder* cannot be depicted. Just as with transitive and intransitive verbs, these nevertheless verbs have a unique distributional profile; these select for a clausal complement. Instead of simply tracking the number or position of nouns, the claim is that children should also be able to track the type of complement, and that this frame should enable appropriate categorization (Gleitman et al. 2005).

Various studies have tested this claim. Papafragou, Cassidy & Gleitman (2004) investigated the contribution of the syntax in the acquisition of mental state verbs by weighing the usefulness of syntactic frames along with other potentially helpful cues, like what is known about the beliefs of the speaker. In their study, 3-5 year-olds were shown narrated videos featuring various characters. At the end of the video, children would hear a novel verb in a particular frame, and children were asked to provide the meaning of that novel verb. In addition to using different frames, the researchers also manipulated the situation, such that one of the characters in the video had either a true belief or false belief about the context. For example, in one of their stories, Matt is on his way to visit his grandmother, but a "big, bad cat" goes to the grandmother's house and hides in her bed, pretending to be her when he arrives. The child would receive a prompt as in (3). In this case, Matt has a false belief that his grandmother is under the covers, and the story has made it clear that this is not the

case (and that this is a false belief).

(3) Did you see that? Matt GORPS that his grandmother is under the covers!

Papafragou, Cassidy & Gleitman found that children were sensitive to the frame and to the context. For all contexts with a clausal complement, children provided a mental state verb 27.2% of the time, compared to just 6.6% of the time when given a transitive frame. While the overall rate of frame compliant, mental state verbs remains low, the rate increases to 41% in false belief contexts alone. Crucially, children also rarely provided a mental state verb when it would be non-compliant with the frame provided. This suggests that while extra-linguistic information is influential, the syntactic frame exerts a powerful influence in terms of narrowing down the hypothesis space of potential meanings.

This class of verbs is able to be subcategorized into representational attitude verbs (e.g., think) and preferential attitude verbs (e.g., *want*). These classes both select for a sentential complement, but not of the same type; the former selects for finite clauses, and the latter selects for non-finite clauses. There are also verbs that belong to both classes, reflecting either a belief or desire, depending on the tense of the complement. The pattern in distribution that distinguishes these sub-classes thus serves as a syntactic cue that children could be relying on to learn these meanings. Harrigan, Hacquard & Lidz (2016) investigated how syntactic bootstrapping might enable children (4-5 years) to learn these categorizations. They focused on the verb *hope* because it can be both representational or preferential (*hope that* vs. *hope to*), and because it is a low frequency item in child-directed speech, making it unlikely that they have prior knowledge of this verb. In their study, children played a game with a puppet that involved shapes (hearts, stars) of different colors (yellow, red). The puppet wants to find red hearts; hearts are almost always red, whereas stars are yellow. As the shapes were being taken out of a box, the puppet could only see a portion of the shape, and only had color to rely on for forming any guesses about which shape was taken from the box. Children would then hear a frame as in (4), would respond either yes or no.

(4) a. Froggy hopes to get a heart/star! desire

b. Froggy hopes that it's a heart/star! belief

Based on response patterns, children evaluated *hope* in accordance to the frame in which it was found; they treated *hope* like *want* when it combined with a non-finite clause as in (a), indicating that the puppet always wants a red heart and not a star. They treated *hope* like *think* when it combined with a finite clause, indicating that the puppet believed that it was a heart only when the shape was red. The findings from this study are support for syntactic bootstrapping, and they also reveal that children are capable of tracking syntactic cues that extend beyond the number and position of arguments. Children are sensitive to other types of structural information, including tense.

Nevertheless, in all of the aforementioned studies, there is a canonical mapping between the arguments and the position they are found in. As mentioned, children have certain expectations about thematic alignment– namely, they expect the argument subject to correspond to the agent, and it typically does. In constructions where the subject is not the agent, children have difficulties accessing an adult-like interpretation. This is the case for constructions in which the subject has no thematic relation with the verb. This is the case with raising verbs, such as *seem*, which does not select for a subject; rather the argument of the lower clause may move into the matrix subject position (5a), or an expletive subject may be used instead (5b).

(5) a. John seems to be sick.

b. It seems (that) John is sick.

From the standpoint of learnability, these constructions are challenging because they require non-canonical mapping. However, syntactic bootstrapping has been appealed to here as well. Becker (2006, 2009) argues that children are able to rely on syntactic cues to learn raising verbs, as these also have a particular distributional profile associated with

them as well. Only raising verbs are compatible with expletive subjects. She conducted a grammaticality-judgement task with 3-4 year-olds, in which children would hear a puppet describe images with either raising or control verbs paired with an expletive subject (as in 6).

(6) a. It seems to be snowing.
b. It's trying to be sunny.

Becker found that 3- and 4-year-olds accepted the raising verbs with the expletive, with 4-year-olds being close to ceiling (92% correct). However, both groups often accepted control verbs with expletive subjects, which was unexpected. Becker attributes this to semantic coercion, where children are more focused on the lower predicate and assess acceptability with the expletive based on this; because expletive subjects are such a strong cue, young children may assume any verb that appears in this frame must be a raising verb, and thus interpret the verb given the frame. It is, however, possible that while expletive subjects are a powerful cue for adult learners (see Becker 2005), children may not be able to recruit this information at this point in development; this could be due to the rarity of expletive subjects in child-directed speech (Becker 2014).

2.3 Case Study: Adjectives

As mentioned, most of the research on syntactic bootstrapping has been centered on nouns and verbs. However, more recent studies have examined how children learn adjectival meanings as well. In this section, I will address how bootstrapping has been extended to the acquisition of gradable adjectives and tough-adjectives in particular. As will be discussed, these studies have demonstrated that children are able to use distributional information to determine adjective meanings.

First, there are different types of adjectives, including both gradable and non-gradable adjectives. Gradable adjectives, such as *tall*, are those that map entities to a degree on a

scale based on a given property (as in 7) (Creswell 1976; von Stechow 1984; Heim 1985, 2000; among others).

(7) λd.λx tall(d)(x) & d $>$ standard (tall)

The entity (x) that is being described must meet or exceed a particular threshold based on a contextually relevant standard. For this reason, what is considered *tall* will depend on what is being evaluated or compared. Within the class of gradable adjectives (GAs), there are two types: relative GAs and absolute GAs. These differ in terms of scale structure. Relative GAs (*tall, big*) have open scales; there is no maximum or minimum standard. Given two objects of different heights, one will be "the tall one," in comparison. Absolute GAs (*full, spotted*), on the other hand, have a scale structure that is either partially or completely closed. For example, an adjective like *full* has a maximum standard. Given two containers, where neither is completely filled, there is no "full one," even if one is filled to a greater degree than the other (see Kyburg & Morreau 2000 for discussion of this diagnostic).

Syrett & Lidz (2010) examined if children (30 months) are sensitive to this distinction between relative and absolute gradable adjectives, and what in the distribution might enable children to make this categorization. They focused specifically on adverbs as a cue for adjective learning. This is because there are restrictions on which adverbs are able to combine with each type of GA, based on scale structure. In their study, they provided the children with novel adjectives modified by adverbs such as *very* (compatible with relative GAs) or *completely* (compatible with absolute GAs). Using the preferential looking paradigm, Syrett & Lidz presented the children with images of objects that could be described in more than one way, having properties that corresponded to relative GAs and absolute GAs (e.g.*tall/short* and *transparent/opaque*). They found that children responded differently depending on the adverbial cue, attending to the object that had a property corresponding to an adjective that could be modified with that particular adverb. They found no significant preference when no adverb was provided, which is consistent with the claim that the adverb

functions as the distributional cue that supports learning, allowing children to "bootstrap" the meaning of the novel adjective. Their findings reveals that, just as with verbs, even young children are capable of making fine-grained distinctions in terms of categorizations; cues in the input allow children to determine how adjectives behave.

Other studies have also considered how different types of cues and frames enable children to learn specific types of gradable adjectives, namely *tough*-adjectives (e.g., *tough, easy, difficult*). These adjectives are typically defined according to their syntactic properties; these do not select for a thematic subject, and are able to participate in the *tough*-construction alternation, in which the agent either remains low and an expletive is inserted, or the agent surfaces in the canonical matrix subject position.

(8) a. Olivia is tough to impress.

b. It is tough to impress Olivia.

Becker (2015) studied what children are able to rely on to learn the meanings of raising predicates, particularly these tough-adjectives. From a learnability perspective, these adjectives are difficult to acquire at least in part because on the surface, raising and control predicates look the same (as in 9a-b below). Here the adjectives happen to both be in the same predicative position with an individual DP in subject position. In the raising example (9a), the argument in subject position is interpreted as the object, and what is being described is the event in the lower clause, not the subject DP.

(9) a. Olivia is [tough [to impress <Olivia>]].

b. Olivia is [eager [PRO to impress (someone)]].

This difference between the constructions is apparent when animacy is considered. Only the tough-adjectives are compatible with an inanimate subject, whereas both are compatible with animate subjects (as above).

(10) a. The rock is tough to hide.

b. *The rock is eager to hide.

Becker (2014, 2015) argued that children to rely on the animacy of the subject NP to learn this distinction. She hypothesized that children would interpret a novel adjective as a tough-adjective if it was found in a syntactic frame with an inanimate subject NP, and as a control adjective otherwise. After children heard these frames in the context of a story, they were asked questions with these same novel adjectives in one of two new frames, one consistent with a raising interpretation (*Is it ADJ to V DP?*) and one consistent with a control interpretation (*Is DP ADJ?*). Children responded significantly faster to grammatical questions that had the novel tough-adjective in the appropriate frame, indicating that they were able to recognize these novel words as tough-adjectives, but that they were able to extend what they had learned to new syntactic contexts.

While the literature on adjective learning within the scope of syntactic bootstrapping is more limited, these previous studies highlight that children are capable of integrating distributional information in order to determine word meanings. However, unlike in the studies on the acquisition of nouns and verbs, these studies have considered semantic information in addition to syntactic cues.

2.4 Remaining Questions

The literature on syntactic bootstrapping clearly indicates that children are paying attention to structure when they are learning word meanings. It enables them to form broad categories, like nouns, verbs, and adjectives, as well as specific subcategories. As illustrated in this chapter, most of the literature on syntactic bootstrapping has been centered on nouns and verbs, but children also produce adjectives early and often in development (see Blackwell 2005; Davies et al. 2020), and must therefore learn how to successfully map adjectival meanings as well.

Moreover, adjective meanings are arguably harder for the learner to acquire because they correspond to properties, and these properties are able to describe a variety of objects and events, and are at times dependent on the context. For example, an adjective like *wooden* could describe e.g. a chair, a bookcase, a toy, or an instrument. Even if the child would hear *Look! This is wooden!* when encountering something wooden, the child would need to be able to abstract away from that particular object to understand that *wooden* corresponds to the property and not the object, and that it does not uniquely identify any given object. With an adjective like *tall*, there is an additional complication; *tall* could describe a e.g., person, a building, a mountain, and– unlike with *wooden*– the same object could be tall in one context but not in another. That is, the Empire State Building is tall compared to other buildings, but not tall when compared to Mount Everest. Speakers may also disagree as to whether or not something is tall or not. Adjectives that are both context-dependent, and sensitive to the person making the claim that the adjective applies, are known as subjective adjectives. These adjectives are the focus of this dissertation, and will serve as a case study in further extending syntactic bootstrapping into the adjectival domain. Previous research on bootstrapping with adjectives as included both syntactic and semantic cues; this dissertation is an attempt to consider the contribution of syntactic frames themselves. In Chapter 3, I will argue that just as with nouns and verbs, there are clusters of syntactic cues that should enable children to learn the meanings of these subjective adjectives.

CHAPTER 3
SUBJECTIVE ADJECTIVES

Beyond determining that words belong to general categories like nouns, verbs, and adjectives, children must be able to make further distinctions within those categories. As discussed in Chapter 2, previous research has indicated that children rely on syntactic cues in order to make these determinations, which has motivated syntactic bootstrapping as a learning mechanism. In this chapter, I will discuss how syntactic bootstrapping is able to be extended to a specific type of adjectives, known as subjective adjectives, such as *fun* or *delicious*. These adjectives pose a particular challenge for learning because they do not correspond to stable properties, but are rather dependent on the discourse context and a *judge*, who is the attitude-holder. In other words, what person A considers to be fun might differ from what person B considers to be fun. There is also no visual correlate for these adjectives. Subjective adjectives thus pose a unique case study for exploring the role of syntax in word learning, and evaluating how powerful syntactic cues are when extra-linguistic information is not available. In the following sections, I will provide an overview of how these adjectives are categorized, before defining what these syntactic cues are.

3.1 Diagnosing Subjectivity

Subjective adjectives are characterized by their ability to appear in what are known as faultless disagreement contexts (see Lasersohn 2005, 2009; Stojanovic 2007; Bylinina 2017). This refers to cases where speakers are able to disagree without either speaker being "wrong" or a contradiction resulting (11-12).

(11) A: This game is fun!
B: No, it is not!

(12) A: This pie is delicious!
B: No, it is not!

Non-subjective adjectives conversely do not participate in faultless disagreement; in (13), only one speaker is able to be right, which results in the infelicity of the response from B. Either the object has the property in question or it does not; there is no speaker-dependence.

(13) A: This chair is wooden.
B: #No, it is not!

Additionally, subjective adjectives are able to be embedded under attitude verbs (those that reflect a belief of the matrix subject) such as *find* and *consider*, as in (14).

(14) a. I consider this game fun.
b. I find this pie (to be) delicious.

Non-subjective adjectives are not able to surface in this syntactic environment.

(15) a. #I consider this chair wooden.
b. #I find this window to be open.

The reason that subjective adjectives are possible in both of these contexts is tied to the fact that these adjectives are judge-dependent. The judge is the one evaluating the applicability of the adjective in a given context; it often corresponds to the speaker (16a), but may also correspond to another named individual (16b).

(16) a. Baseball is fun (for me).
b. Baseball is fun for John.

There have been different attempts to formalize judge-dependence in the literature, with

different theories emerging. One approach is to analyze the judge as an index of evaluation, in which subjective adjectives are evaluated relative to a context and a judge: $[[fun]]^{c;w,t,j}$ = $\lambda\ x_e$. x is fun in *w* at *t* for *j* (Lasersohn 2005, 2009). Another approach is to interpret the judge as an argument, which may either be overt or correspond to a null "judge" pronoun (Stephenson 2007). Throughout this chapter, I refer to the judge as simply the attitude-holder to remain neutral between these two accounts, as the syntactic profiles of these adjectives do not depend on the judge being analyzed as an index or as a pronoun. Additionally, both of these accounts assume that the judge may be expressed overtly, thus under both accounts an overt judge may surface in the syntax, as in the examples above.

3.2 Types of Subjective Adjectives

The diagnostics mentioned above are associated with all subjective adjectives, but this category is able to be further subdivided into specific classes. Most of the literature on subjective adjectives has focused on a subset of subjective adjectives, which have been referred to as predicates of personal taste (PPTs), with an adjective like *tasty* being offered as the canonical example. However, the focus on PPTs in particular has obscured the fact that subjective adjectives do not exhibit uniform behavior. For example, while *tasty* and *tall* are both subjective, only the former allows the judge to be expressed overtly. Note that the judge differs from a comparison class, which specifies the standard for evaluation and corresponds to singular DP (18) (see discussion in Bylinina 2014 for syntactic and semantic properties of comparison-classes).

(17) a. Chocolate cake is tasty to me/to children.
b. #John is tall to/for me.

(18) John is tall for a football player.

Both of these adjectives differ from other subjective adjectives like *tough*, which combine

with a *for*-phrase and an infinitival (19a).

(19) a. This mountain is tough for me to climb.

b. #This chocolate cake is tasty for me to eat.

c. #John is tall for me to ???.

Examples such as these illustrate that within the class of subjective adjectives, there are additional distinctions to be made and that it is not a homogeneous class of predicates (Bylinina 2017).

In the following sections, I will be focusing on five different types of subjective adjectives, which I will refer to in terms of a representative adjective within that class: the TALL-class, the TASTY-class, the PRETTY-class, the TOUGH-class, and the SMART-class. These classes are defined according to a collection of properties that all adjectives in this class share. As will become evident by the end of this section, there is considerable overlap in terms of individual properties that these adjective share, but each class has a unique profile when all of these properties are taken together. Each class is associated with a set of frames, and the distribution of these frames enables categorization.

3.2.1 Adjective Profile: Tall

Although subjective adjectives are characterized by faultless disagreement, not all gradable adjectives remain subjective in all forms. Certain adjectives, like tall and *short*, are only subjective in their positive (non-comparative) form. This is because what is subjective about these adjectives is the threshold, e.g., what speakers consider to be "tall" in a given context. However, this subjectivity disappears when these adjectives are in their comparative forms. This is due to the fact that these adjectives are uni-dimensional (see Sassoon 2013; these are also referred to as non-dimensional by Klein 1980; Bierwisch 1989). There is only one way to order objects along the scale that corresponds to the adjective in question, which means that there is no scalar variation (Kennedy 2007). For these reasons, it is

not possible to have faultless disagreement with adjectives like *tall* in the comparative form (as exemplified in the contrast below) (Bylinina 2014, 2017).

(20) A: Peter is tall. faultless disagreement
B: No, he is not!

(21) A: Peter (6'2") is taller than Nick (5'8"). scalar variation
B: #No, he is not!

The adjectives in the TALL-class differ from other subjective adjectives with respect to scalar variation. Other adjectives like *pretty, tasty, tough* and *smart* do not exhibit this asymmetry, and remain subjective in positive and comparative forms. This is because what is subjective is the degree to which an individual exhibits a property, and not what the threshold should be. In terms of judge-dependence, this means that the TALL-class is only judge-dependent in the positive form. Other adjectives that do exhibit scalar variation, and are always compatible in faultless disagreement contexts, are judge-dependent in all forms.

(22) A: This Monet is pretty. faultless disagreement
B: No, it is not!

(23) A: This Monet is prettier than that Courbet. scalar variation
B: No, the Courbet is prettier!

The TALL-class, being comprised of one dimensional adjectives, contrasts with multidimensional adjectives. Multidimensionality refers to the ability to be evaluated in more than one respect (along more than one dimension) and, specifically, having a dimension argument as part of their semantics (Sassoon 2013). This results in another asymmetry; only multidimensional GAs are compatible with certain adverbial phrases like *in some/several/all respects* or *except for*, which results in a contrast between adjectives in the TALL-class (24a) and the multidimensional ones (24b). There is no clear, felicitous way of combining

the adjective with either of these phrases.

(24) a. #John is tall except for ???

b. The race is easy (to run) except for the hills.

The TALL-class is not only evaluated according to a single dimension, the adjectives in this class are also uniquely able to combine with measure phrases that denote where exactly the individual is mapped to the scale (25).[1]

(25) a. John is 6 feet tall.

b. The shelf is 18 inches wide.

In addition, although the TALL-class is judge-dependent (in the positive form), this dependence is expressed in a different way from the other adjectives of interest here. Typically subjective adjectives are able to be embedded under verbs that also express a subjective attitude, with *consider* and *find* being the oft-cited examples (see Stojanovic 2007). Non-subjective-adjectives cannot be embedded under these same verbs.

(26) a. I consider Peter (to be) tall.

b. #I consider Peter (to be) left-handed.

Nevertheless, the ability to be embedded under attitude verbs intersects with another property that is associated with certain subjective adjectives, that of the ability to take an "experiencer" requirement. Adjectives in the TALL-class do not take an experiencer. This results in (at least) two observations: first, embedding under the verb *find* is somewhat odd (Stojanovic 2016; McNally & Stojanovic 2017), although this is not ungrammatical (just potentially more marked).

[1]However, note that when these adjectives combine with measure phrases, they are no longer "subjective" in the sense that faultless disagreement is no longer possible.

(27) #I find Peter tall.

Second, the TALL-class does not admit a *for*-phrase with an experiencer argument, also referred to as an experiencer-phrase (Bylinina 2017). In order to express who the judge is, other means must be employed (29).

(28) #Peter is tall to/for me/Nick.

(29) According to Olivia, Peter is tall.

Lastly, adjectives in the TALL-class describe entities and not events, and as such these adjectives select for individual NP arguments (Gluckman 2021). For this reason, (30a) is grammatical, but (30b) is not.

(30) a. Peter is tall.

b. #Hiking this mountain is tall.

Adjectives in the TALL-class are also unable to select for an infinitival complement (31), which is consistent with their incompatibility with eventive predicates.

(31) ??John is tall to ride this roller coaster.

They are only able to do so indirectly, if the adjective combines with a standard, which specifies the threshold for comparison or the relevant comparison class. Standards include *than*-clauses, as in comparatives (32a), but also *too* and *enough* (32b-c). In other words, the individual (John) is evaluated with respect to a particular scale (for height) that is contextualized relative to the purpose of a particular action (riding roller coasters).

(32) a. John is taller than Tom.

b. John is tall enough to ride this roller coaster.

c. John is too tall to ride this roller coaster.

Taken together, these properties enable us to build a profile for the TALL-class, as exhibited in the preliminary table below.

Table 3.1: Adjective Profiles (Tall)

Adjective	Faultless	Scalar Variation	NPs	Events	Infin.	MPs
TALL	Yes	No	Yes	No	No	Yes
TOUGH						
TASTY						
PRETTY						
SMART						

3.2.2 Adjective Profile: Tough

The second class of subjective adjectives is the TOUGH-class, which includes predicates such as *tough, easy, difficult, hard,* or *amazing, fun*. These adjectives are indeed known as *tough*-adjectives in the literature, but here I am specifically referring to *tough*-adjectives that are subjective; only these are members of the TOUGH-class for the present purposes. While most *tough*-adjectives are subjective, there are notable exceptions to this (e.g. *legal/illegal, common/uncommon, rare*), in spite of shared syntactic properties. All of the adjectives that I characterize as being part of the TOUGH-class participate in faultless disagreement, and remain subjective in all forms, positive and comparative. As a result, they always participate in faultless disagreement contexts and exhibit scalar variation, as demonstrated below; neither (33a) nor (33b) results in a contradiction.

(33) a. A: Great Expectations is easy to read.
B: No, it is not!

b. A: Great Expectations is easier to read than Wuthering Heights.
B: No, Wuthering Heights is easier to read!

Conceptually, these adjectives are distinct from the other classes due to the fact that they

describe events and not individuals.[2] In the previous example, the adjective *easy* describes the reading event, and not the book. This fact about the TOUGH-class is highlighted by their ability to select for eventive subjects, e.g., verbs, gerunds, or event nominals (see Pesetsky 1987 and many others).

(34) Reading this book is easy.

This eventive property of those adjectives in the TOUGH-class is also associated with their ability to participate in what is known as the *tough*-alternation (or *tough*-construction (TCs)), as in (35).

(35) a. This mountain is tough/easy to climb. TC

b. Climbing this mountain is tough/easy. TC

c. It is tough/easy to climb this mountain. Non-TC

Other types of (subjective and non-subjective) adjectives do not participate in this alternation, and do not allow for expletive subjects (36). As this alternation and co-occurrence with expletive subjects is specific to the TOUGH-class, these particular frames are unique to these adjectives.

(36) a. ??This mountain is tall to climb.[3]

b. *It is tall to climb this mountain.

In the TC-variant (35a), the subject DP (this mountain) is interpreted as the object of the infinitival clause (to climb), where it is located in the non-TC-variant in (35c). The object is often analyzed as having moved into the subject position to derive the *tough*-construction,

[2]There are, of course, polysemous cases, in which an adjective can describe both an individual and an event, but the meaning differs. An individual can be *tough* (strong) and an event can be *tough* (challenging). In this case, only the latter version is in the TOUGH-class.

[3]The extent to which this is acceptable at all seems to depend on being able to interpret the infinitival as meaning something akin to "for climbing," as in an attributive-with-infinitival (AIC) construction (Fleisher 2011).

otherwise an expletive (non-thematic) subject is inserted to satisfy the EPP if the object remains in its base position (Postal & Ross 1971; Hicks 2003, 2009; Hartman 2009, 2012; but see also Jacobson 1992; Rezac 2004, 2006 for different, alternative analyses). Regardless of the exact analysis assumed, semantically the subject NP is interpreted as an object. For this reason, the TOUGH-class selects for infinitival clauses, which are also obligatory, given that the adjective is not predicating over the individual in the matrix clause.[4] This distinguishes TOUGH-class adjectives from TALL-class adjectives, in which case the adjective is describing a property of the individual NP and not an event.

While it is possible for adjectives in the TOUGH-class to surface without an infinitival clause, this is argued to be possible only in cases where the clause is able to be recovered via context (Pesetsky 1987; Hicks 2003l Gluckman 2021). In the above example, this means that it is the climbing event that is tough, not the mountain. In the example below, (37a) could be understood to mean (37b)– math problems are typically things that are solved. However, in both (38a) and (38b), it is still *solving* the problem that is tough, not the math problem itself. This becomes clearer in (37c), where the infinitival cannot be dropped without heavy contextual support that would enable the listener to understand that fitting the problem on one page is what is difficult.

(37) a. This math problem is tough.

b. This math problem is tough to solve.

c. This math problem is tough to fit on one page.

Thus, although Williams (1983) and others have conversely argued that the TOUGH-class may take an individual/non-event-denoting NP (as superficially appears to be the case in (37a)), the example in (38) below illustrate that these "exceptions" do not hold up if the intended meaning is not as recoverable or understood; without context, it is not clear if the

[4]Gluckman (2021) points out that there are exceptions with adjectives like 'difficult' (as in, *Sam is (being) difficult*), though it is not clear to me if these are true exceptions, or if there is a more idiomatic use of this phrase to describe someone being fussy/stubborn/uncooperative.

pie is easy to eat/bake/transport/etc. Examples with an expletive subject and no infinitival are additionally completely degraded (39), and provide further support that the infinitival is needed to convey the meaning of these adjectives.

(38) #This pie is easy.

(39) a. #It is tough for this mountain.
b. #It is easy for this pie.

Because the infinitival is crucial to the meaning of the adjective, I assume that the infinitival is an argument and that TOUGH-class adjectives behave similarly to verbs like *eat* that are optionally transitive (taking an understood or null argument), and unlike transitive verbs like *sleep* that do not select for arguments. For this reason, when discussing the syntactic profile for the TOUGH-class, I claim that the infinitival is "required" in spite of the fact that the infinitival clause may not surface. I assume that it has been elided and is still syntactically represented in the grammar.

(40) a. This math problem is tough (to solve).
b. Olivia ate (a hoagie).
c. Olivia sleeps.

As with transitive verbs (optionally transitive or otherwise), the adjective cannot be separated from the infinitival clause with certain modifiers, namely those that are uncontroversially adjuncts, such as the temporal modifiers below.

(41) a. *Olivia ate yesterday a hoagie.
b. *Olivia was tough yesterday to impress.

Lastly, the judge is able to be expressed via an overt judge argument in a *for*-phrase (also referred to as a judge-PP (as in Bylinina 2014)). This judge is also known as the experiencer

and an intervening argument in the literature on *tough*-adjectives. This again contrasts with the TALL-class.

(42) a. This book is easy (for me) to read.

b. #John is tall for me.

Taken together, this gives us the following profile for the TOUGH-class, found in the updated table below.

Table 3.2: Adjective Profiles (Tough)

Adjective	Faultless	Scalar Var.	NPs	Events	Infin.	MP	JudgePP	Expletive
TALL	Yes	No	Yes	No	No	Yes	No	No
TOUGH	Yes	Yes	No	Yes	Required	No	Yes	Yes
TASTY								
PRETTY								
SMART								

3.2.3 Adjective Profile: Tasty

The next class of adjectives is the TASTY-class, which includes *tasty*, and others such as *delicious*, *smelly, fragrant, soft, cozy, sweet, flavorful*. These are all adjectives that are typically referred to in the literature as predicates of personal taste (PPTs) (Anand 2009; Lasersohn 2005, 2009; Stephenson 2007; Pearson 2013; among others). Here I restrict the TASTY-class to PPTs that do not belong to the TOUGH-class, though many (if not all) of the adjectives in the TOUGH-class may also be characterized as belonging to the "superset" of PPTs (Bylinina 2013; Gluckman 2021), as will become evident based on their properties. That is, while those in the TOUGH-class participate in the *tough*-alternation, those in the TASTY-class do not.

(43) a. This soup is tough to prepare. TOUGH-class

b. It is tough to prepare this soup.

(44) a. This soup is delicious. TASTY-class

b. #It is delicious (to prepare this soup).

In regard to their status as PPTs, the adjectives in the TASTY-class are able to project an overt judge argument (Pearson 2013). This judge argument is found inside a PP, which is headed by 'to' or 'for' (45).

(45) a. Pasta tastes delicious to me.

b. This hot sauce is spicy for me.

Unlike with the TOUGH-class, the judge and the experiencer must co-refer. This is what Bylinina (2014) refers to as the judge=experiencer requirement for PPTs (46a). When they do not, the result is degraded (46b).

(46) a. Pasta tastes delicious to me.

b. ?Pasta tastes delicious to John.

Although both the TASTY-class and the TOUGH-class select for-phrases, these for-phrases are not equivalent. With the former, the for-phrase introduces a judge/experiencer, whereas with the latter the for-phrase corresponds to the experiencer. These is no difference in acceptability with the TOUGH-class when the experiencer differs (47).

(47) a. Pasta is easy for me to make.

b. Pasta is easy for John to make.

For the TASTY-class, there thus seems to be a general requirement that these are first-person oriented when there is no overt judge specified, because direct experience is needed (Pearson 2013); according to Lasersohn (2005), adjectives like *tasty* are first-person oriented by default. This requirement explains why (48) is infelicitous.[5] It sounds odd to

[5]However, as Lasersohn (2005) and others have noted, although PPTs generally reflect the speaker's

claim that something is e.g. *tasty* without actually tasting it. Pearson (2013) provides the continuation in (49) as a diagnostic for illuminating the direct experience requirement for these adjectives.

(48) #The cat food is tasty.

(49) #Pasta tastes delicious to me, but I have never eaten it.

However, when the judge is not specified overtly with a for-phrase, the covert judge is able to receive a generic interpretation (Pearson 2021), in which case the "judgement" is not speaker-specific, but based on a sort of general consensus (see also Kaiser & Lee 2018 for experimental support for this claim).

(50) Chocolate is tasty.

In addition, there are other restrictions on the kind of frames that adjectives belonging to the TASTY-class can be found in. They do not require or select for an infinitival clause, as illustrated in (51) (Bylinina 2017). Just like the adjectives in the TALL-class, adjectives in the TASTY-class select for individual DPs (52a), and not events (52b). Expletive subjects are also not possible (52c). These properties distinguish TALL and TASTY from TOUGH.

(51) a. Sardines are smelly.
b. #Sardines are smelly to eat/smell.

(52) a. This pasta is delicious.
b. #Eating this pasta is delicious.
c. #It is delicious to eat pasta.

In sum, while the TOUGH-class and the TASTY-class are both subgroups of PPTs, they

perspective, they can reflect someone else's perspective, so long as the discourse context makes this other individual salient in some way.

differ in other important ways. These two classes are also distinct from the TALL-class, as summarized in Table 3.3.

Table 3.3: Adjective Profiles (Tasty)

Adjective	Faultless	Scalar Var.	NPs	Events	Infin	MPs	JudgePP	Expletive
TALL	Yes	No	Yes	No	No	Yes	No	No
TOUGH	Yes	Yes	No	Yes	Required	No	Yes	Yes
TASTY	Yes	Yes	Yes	No	No	No	Yes	No
PRETTY								
SMART								

3.2.4 Adjective Profile: Pretty

A separate class of subjective adjectives is the PRETTY-class, which includes e.g., *pretty, gorgeous, beautiful* and *attractive*. The adjectives in this class have been referred to as aesthetic adjectives, or evaluative adjectives. However, these terms have been used in different ways in the literature, and (depending on how these are defined) pick out a diverse set of adjectives. Here I categorize those in the PRETTY-class in terms of those that optionally select for an infinitival clause (53a), and whose subject is interpreted as the object of that infinitival clause. However, unlike with the TOUGH-class, there is no tough-alternation, and expletive subjects are not possible (53b). I follow Anderson (2005) in interpreting the subject of these constructions as thematic, thus eliminating the possibility of the expletive.

(53) a. These flowers are pretty (to photograph).

b. *It is pretty to photograph these flowers.

Not only is the infinitive not required, but inclusion of the infinitival does not seem to change the semantics of the predicate; *pretty* corresponds to a property that is exhibited by the individual-denoting NP. This is unlike TOUGH-class adjectives, which are interpreted as eventive with or without the infinitival clause. While there are polysemous adjectives that have TOUGH and non-TOUGH meanings (*tough, hard*) this does not explain the op-

tionality here, as there is no change in meaning; whereas (54a) entails (54b), there is no such entailment between (55a) and (55b), as the adjective describes the baking event in (55a) and not a physical property of the bread (55b).

(54) a. This painting is beautiful to display.
b. This painting is beautiful.

(55) a. This bread is hard to bake.
b. This bread is hard.

In other words, the infinitive is truly optional with the PRETTY-class.

Along these lines, because the PRETTY-class selects for individuals (as in 53-54) and not events, gerunds are not possible in subject position (56). Thus, while the PRETTY-class patterns with the TOUGH-class by appearing in what on the surface resembles a tough-construction frame, it resembles the TALL and TASTY classes in terms of other selectional properties.

(56) #Looking at this painting is beautiful.

In addition, adjectives in the PRETTY-class seem able to combine with a *for*-phrase, although it is not clear if this argument is a judge PP (intervening experiencer argument), or if this phrase is the subject of an embedded CP.

(57) a. These flowers are pretty <u>for me</u> to photograph.
b. This sunset is beautiful <u>for the artist</u> to paint.

Lastly, these predicates also exhibit faultless disagreement and scalar variation, like those in both the TOUGH and TASTY-class. Speakers may disagree about whether and to what extent an object exhibits the property corresponding to the adjective without either being wrong. The adjective remains subjective in its positive and comparative forms.

(58) A: This Van Gogh is prettier than that Monet!

B: No, this Monet is prettier than that Van Gogh!

Table 3.4: Adjective Profiles (Pretty)

Adjective	Faultless	Scalar Var.	NPs	Events	Infin.	MPs	JudgePP	Expletive
TALL	Yes	No	Yes	No	No	Yes	No	No
TOUGH	Yes	Yes	No	Yes	Required	No	Yes	Yes
TASTY	Yes	Yes	Yes	No	No	No	Yes	No
PRETTY	Yes	Yes	Yes	No	Optional	No	Yes	No
SMART								

3.2.5 Adjective Profile: Smart

Lastly, there is another group of adjectives that belong to the SMART-class. These are adjectives like *smart, silly, wise, foolish*. As with the TOUGH, TASTY, and PRETTY classes, these adjectives remain subjective in their positive and comparative forms, and exhibit scalar variation.

(59) A: Olivia is smart!

B: No, she is not!

(60) A: Olivia is smarter than Alex!

B: No, Alex is smarter than Olivia!

On the surface, these adjectives participate in an alternation that resembles the *tough*-alternation. They can take either a thematic subject or an expletive subject. However, the matrix subject is not interpreted as the object of the infinitival clause, but rather as the subject of that clause, co-indexed with PRO (61c) (Stowell 1991). The construction in (61c) has been referred to as "evaluative control" (see Stowell 1991; Kertz 2010).

(61) a. Mary is smart to take the train.

b. It is smart of Mary to take the train.

c. Mary is smart [PRO to take the train].

The example in (61b) has a *of*-phrase that resembles the judge/experiencer *for*-phrase found with other categories of subjective adjectives. However, unlike the TOUGH and PRETTY classes, a *of*-phrase is only possible when there is an expletive subject (62a); when there is an individual DP subject, no such phrase is possible (62b). The object does not move in evaluative control constructions (63), regardless of the inclusion of this phrase.

(62) a. It is smart (of Mary) to take the train.

b. #Mary is smart of Amanda to take the train.

(63) #The train is smart of Mary to take.

Additionally, the SMART-class selects for animate subjects, which is consistent with their status as control predicates. Inanimate subjects are not possible (or at least, are degraded), even when the expletive variant of the same sentence is acceptable (64-65). This asymmetry in terms of animacy distinguishes the SMART-class from the other classes of subjective adjectives considered here, including the TOUGH-class.

(64) a. #The book is smart to read.

b. It is smart to read the book.

(65) a. ??This route is wise to follow.

b. It is wise to follow this route.

Although the SMART-class is compatible with individual DP subjects, the adjective describes the subject only when there is no infinitival clause. When the adjective is found in an evaluative control construction, there is no entailment that the property denoted by the adjective applies to the subject (66b). This means that when the adjective is found without the infinitival, it behaves like a member of the TALL, TASTY, and PRETTY-class, but like

the TOUGH-class when in an evaluative control construction.

(66) a. Mary is smart.

b. Mary is smart to take the train.Mary is smart.

(67) a. Mary is tough to impress.

b. Mary is tough to impress.Mary is tough.

This subclass is overall rather difficult to define because of its hybrid nature. It displays characteristics of raising predicates (expletive subjects, superficial tough-alternation) and characteristics that are not (sensitivity to animacy (see Kertz 2010 for other features of evaluative control). Additionally, there is overlap between the TOUGH and SMART-class. As mentioned, here I define the SMART-class in terms of evaluative control, but most (if not all) adjectives that are compatible in these evaluative control constructions also compatible in *tough*-constructions. The reverse is not true; not all TOUGH-class adjectives are found in evaluative control constructions. In fact, only a small set of adjectives seem to participate in this alternation.

(68) a. This book is smart/wise to read. TC

b. Olivia is smart/wise to read this book. EC

Other adjectives, namely *good* and *bad*, are unique in that they participate in EC but seem less sensitive to animacy restrictions, in that inanimate subjects are possible with both an TC and EC usage. However, expletive subjects are only when it is used as a TOUGH-class adjective (69), and animate subjects also seem to be degraded, which is not predicted (70).

(69) a. Coffee is good to jumpstart the day.

b. #It is good of coffee to jumpstart the day

(70) a. Coffee is good to drink.

b. It is good to drink coffee.

The reason for this varied behavior with *good/bad* could potentially be tied to the fact that this adjective seems to cover a range of meanings, and are potentially semantically weakened (indeterminate). I will categorize *good/bad* as members of the TOUGH-class alone for the purpose of this research, given that the EC examples seem to be limited.

Table 3.5: Adjective Profiles (Pretty)

Adjective	Faultless	Scalar Var.	NPs	Events	Infin.	MPs	JudgePP	Expletive
TALL	Yes	No	Yes	No	No	Yes	No	No
TOUGH	Yes	Yes	No	Yes	Required	No	Yes	Yes
TASTY	Yes	Yes	Yes	No	No	No	Yes	No
PRETTY	Yes	Yes	Yes	No	Optional	No	Yes	No
SMART	Yes	Yes	Yes	Yes	Optional	No	Yes	Yes

3.3 Putting it Together: Patterns

Depending on the property in question, subjective adjectives may be grouped in different ways. Each of the classes considered here is associated with a unique syntactic profile, and is found in specific frames. As I will argue in Chapter 4, learners need to keep track of several different properties in order to figure out which class any given adjective belongs to and to determine the meaning of that adjective.

What complicates the learning process is that the profiles for these classes often overlap, which means that it is not a single property that distinguishes all of them, but a collection of properties (see Table 3.5). Given that each adjective may also be found in a variety of frames, the child will encounter the adjective in different environments, with a subset of these syntactic cues. For example, while the TALL-class is uniquely associated with measure phrases, children will not always hear *tall* with one. Similarly, although the TOUGH and SMART-class may be found with expletive subjects, adjectives in these classes may be found in other frames, with different kinds of subjects. The consequence of this variability is that learners must track cues within and across frames for categorization. Children are

sensitive to syntactic information (Mintz 2003; Weisleder & Waxman 2010; among others). For this reason, the syntactic environments in which subjective adjectives are found should enable children to categorize them.

CHAPTER 4
ADJECTIVES IN THE EXPOSURE LANGUAGE

In spite of the well-known limitations of observational learning, children are nevertheless able to acquire the meanings of novel words. Syntactic bootstrapping is a pivotal claim in the acquisition literature about how this is possible: children rely on the syntactic environment in which a word is found in order to determine its meaning, given predictable mappings between syntax and semantics (Landau & Gleitman 1985; Gleitman 1990). The particular environment that is associated with a given word is referred to as a frame. Previously in Chapter 2, for example, we saw that children expect the number of participants to be linked to the number of arguments, enabling them to successfully distinguish between transitive and intransitive verbs when given frames with and without a direct object. Syntactic bootstrapping is thus predicated on syntactic information (frames) being available to the learner that supports particular categorizations. A particular frame might be helpful in theory, but if learners are not exposed to it then they cannot be reasonably expected to learn from it. The amount of exposure needed for successful learning is an open question, but previous research illustrates that children are able to learn from impoverished input (see e.g. Yang 2002, 2004). In other words, a given frame may be rare while still being informative.

In Chapter 3, I discussed the category of subjective adjectives, and how these adjectives are able to be divided into particular subcategories based on syntactic and semantic criteria in the literature. I focused on five classes of subjective adjectives, which I refer to in terms of a canonical member of that class: TOUGH, SMART, PRETTY, TALL and TASTY. Although these classes share particular syntactic environments, I argued that they are characterized by a unique set of frames. In this chapter, I examine if the different subcategories of subjective adjectives are reliably found in distinct syntactic frames that should

enable mapping these frames to the meaning of the adjective. I address this by conducting a corpus-based analysis of the language that children are exposed to (the input) to examine the environments in which adjectives are found, and examining if these environments support subcategorization. This chapter is organized as follows: in Section 4.1, I detail the parameters and methodology for the corpus search and subsequent analysis. In Section 4.2, I provide the results, focusing on the classes of subjective adjectives of interest here and how these are distributed in the input relative to one another, and to other types of (non-subjective) adjectives. Then, in Section 4.3, I discuss these findings before offering conclusions in Section 4.4.

4.1 Corpora and Methods

4.1.1 Corpora

We included the following English-language (US and UK) corpora from the Child Language Data Exchange System database (CHILDES) (MacWhinney 2000) for this analysis: Belfast (Barbara and Conor), Bliss (with 7 target children), Bloom (Peter), Braunwald (Laura), Brown (Adam and Sarah), Clark (Shem), Gathercole (with 14 target children), Kuczaj (Abe), Sachs (Naomi), Suppes (Nina), Wells (all 32 subcorpora)(Bliss 1988; Bloom et al. 1974; Braunwald 1971; Brown 1973; Clark 1978; Gathercole 1986; Henry 1995; Kuczaj 1977; Sachs 1984; Suppes 1974; Wells 1981). This amounts to 44 corpora in total. These corpora were targeted because they contained interactions between children and adults, and featured spontaneous, naturalistic productions with either limited or no reading or other scripted dialogue. The children in these corpora are between 2 and 6 years of age.

4.1.2 Method

The CHILDES database includes transcripts for each of the files in the corpora. These transcripts include morphological information, which is found in a separate tier below each line of dialogue (see (71) for an example). This tier provides a morpheme-by-morpheme

gloss, and specifies the grammatical category for each word.

(71) MOT: That balloon is strong.
%mor: det:dem|that n|balloon cop|be&3S adj|strong

After downloading the corpora, I searched through them via the program CLAN. This program enables researchers to search for particular items within the transcript. I used the kwal command in (72) to extract all of the utterances with adjectives.

(72) kwal +t%mor +s“adj|*” -w1 +w1

This command tells CLAN to search the morphological tiers (%mor) for elements that have been labeled as adjectives. The asterisk (wildcard) indicates that anything tagged as an adjective (proceeded by adj| in the %mor tier) should be returned. This command thus targets all adjectives, and not simply those belonging to the subjective class. The reason for this is twofold: searching for particular subjective adjectives would not provide the full range of those that may be in the input, and considering only subjective adjectives may fail to reveal larger patterns in terms of the syntactic environments in which other adjectives surface. The last part of the command line instructs CLAN to return the line proceeding the target line (-w1) and the line following it (+w1); this is to provide additional context, and because lines of dialogue occasionally spill over into the next line. The corpus search yielded approximately 37,100 adjective tokens and 1,350 adjective types.

The output from CLAN was then saved in Excel to be reviewed by hand for subsequent analysis. A team of undergraduate research assistants from the Rutgers University Laboratory for Developmental Language Studies assisted with identifying adjectives from these files. We identified the adjective found in each utterance, creating an entry for each one in the Excel document. This required isolating the adjective identified in the string of text by CLAN, and checking that was was identified was in fact an adjective. Although the

kwal command returns anything coded as an adjective, there are errors of commission and omission in the corpora. The former refers to times when something that is not an adjective was coded as such, as in the example in (73); here what is coded as an adjective is a noun with a contracted copula. We filtered out any such errors. The latter type of error refers to adjectives that have been missed by CLAN because they were mistakenly coded as belonging to another part of speech (74); in this example, the adjective *sticky* was incorrectly coded as a noun. We corrected for such omissions by creating an entry for these adjectives.

(73) MOT: When the baby's out? (MOT, Braunwald, file 030125b, line 776)
con*j*|when det:art|the adj|baby&dn-POSS n|out ?

(74) MOT: Is it getting less sticky honey ? (MOT, Sachs file 02112, line 2128)
aux|be3S pro:per|it part|get-PRESP adj|less n|sticky n|honey ?

Lines that have multiple adjectives were copied so that each adjective had its own entry in Excel. In addition, In these transcripts, possessive nouns were coded as adjectives, however possessives were not included in this analysis and were coded as N/A. Quantity-based terms like *much, more, less* (as in 74) were also excluded for this analysis.

We aimed to be conservative, and avoid making certain assumptions about the grammar. For example, we did not assume a separate categorization for words that belong to the adjectival category, but appear as both adjectives and adverbs. A common example of this comes from the word *pretty*, as in *pretty flowers* (adjective) and *pretty nice flowers* (adverb). We coded both instances as adjectives, given that the learner still needs to catalog and (eventually) distinguish these uses, and they share the same relative distributional signature. For the latter example, both *pretty* and *nice* were coded as adjectives, and *pretty* as adverb for *nice*; we followed the same procedure for all such cases were adjectives surfaced as adverbs or another grammatical category. However, we made an exception for discourse markers (e.g. *okay, right*), as in (76). Although these are also adjectives, and learners will

need to distinguish these instances apart too, these discourse markers do not have quite the same distribution as their non-discourse-marker usage; these tend to be (fragment) tag questions or dislocations, as opposed to in pre/post-nominal or predicative position (76). The concern was that including these would rapidly inflate the number of tokens for these adjectives, obscuring other potential patterns.

(75) Oh right, yes. (MOT, Belfast-Connor, file 030827, line 855)

(76) Is that right? (MOT, Belfast-Connor, file 030827, line 399)

Adjectives that are part of fixed compounds (e.g. *hot dog, nursery school*), and imitations or repetitions of the same line were not included in the analysis.

In addition to identifying the adjective, we also recorded if it was found in a particular syntactic environment. Specifically, we recorded if there was an adverb before the adjective, as in (77), as well as standards or complements that followed proceeded or followed the adjective.

(77) a. You're so silly. (MOT, Suppes file 020024, line 1099)

b. They're really nice. (MOT, Suppes, file 01116, line 886)

There are different types of standards and complements found with adjectives. Standards included *than*-phrases (as in comparatives, 78a-b) or *as*-phrases (as in equatives, 79), as well as *too*-phrases (80), and *for*-phrases that provide the comparison class (81).

(78) She's bigger than you. (MOT, Brown-Sarah, line 1747)

(79) She's almost as big as you are. (LOI, Bloom-Peter, file 020812, line 14580)

(80) He may be too big for his chair. (LOI, Bloom-Peter, file 020522, line 1567)

(81) That's a funny name for a rocket ship. (MOT, Brown-Adam, file 030304, line 1942)

Complements refer to phrases (or heads) either selected by and/or modifying or restricting the adjective in some way. This includes clauses (non-finite or finite), as in (82). In these examples, the adjective is predicating over the event or proposition in the embedded clause (e.g. standing up).

(82) a. It's easy for the horse to stand up. (LOI, Bloom-Peter, line 1487)

b. I was afraid he was hurt. (LYN, Bloom-Peter, line 8795)

Other types of complements include other types of *for*-phrases, such as those that correspond to judge/experiencer arguments (as in 83a), or functional standard/ purpose clause (83b-c).

(83) a. It's very hard for you to talk into the microphone when you're drinking. (FAT, Sachs, file 020909, line 1145)

b. Good for shoes too, huh? (MEL, Brown-Sarah, file 3116, line 2139)

c. [This is] good for headaches. (FAT, Wells-Debbie, file 020206, line 828)

NPs that are selected by the adjective (and thus serve to restrict the meaning) are included as complements as well; these are specifically nouns that either proceed or are embedded in a phrase or clause that also serves to restrict the meaning (84a) or those that surface on their own (84b) but also restrict the meaning of the adjective as opposed to being the modified noun (as in 85, where *dog* is not coded as a complement).

(84) a. You could have your own room with a big chalkboard to draw on. (MOT, Kuczaj, file 50011, line 44)

b. Is it easier this way? (URS, Brown-Adam, file 040115, 1760)

(85) He's a nice dog. (MOT, Suppes, line 733)

Next, I categorized each adjective as either subjective or non-subjective (other) and

further sub-categorized the subjective adjectives by type. This was determined via faultless disagreement; only subjective adjectives felicitously participate in faultless disagreement (see Stojanovic 2007; Lasersohn 2009). For example, an adjective like *fun* is subjective because two speakers can disagree about whether or not something is fun or not without a contradiction arising. An adjective like *real* is not, as something is either real or not– only one speaker can be right.

(86) a. A: This game is fun (to play)! subjective
B: No, it is not fun!
b. A: Leprechauns are real. non-subjective
B: No, they are not real!

Absolute gradable adjectives such as *full* or *bumpy* were not included in the subjective categorization.[1] Emotion adjectives (happy/sad/afraid/glad/upset) were also categorized as non-subjective. While it does seem possible to disagree about e.g. who is happier without a contradiction arising (87b), faultless disagreement does not seem to be possible in the positive form (87). If Speaker A claims that someone is happy, and Speaker B disagrees, presumably only one of them can be right.

(87) a. A: Amanda is happy!
B: #No, she is not happy!
b. A: Amanda is happier than Olivia!
B: No, Olivia is happier than Amanda!

Any adjective that passed the diagnostic for faultless disagreement was subsequently sorted into one of the following subcategories of subjective adjectives: TOUGH, SMART,

[1] At least some absolute adjectives like 'clean' and 'dirty' are admittedly borderline cases and experimental evidence confirms that speakers do not agree if these are necessarily faultless (Solt 2015). But, even so, these adjectives do not behave like the canonical examples like 'fun' or 'interesting/boring' as are typically discussed in the literature.

PRETTY, TALL, or TASTY. As mentioned in Chapter 3, these adjective classes are defined by particular characteristics that distinguish them from the others. The following criteria was considered when sorting these adjectives. The TALL-class is distinguishable from all other classes in that it is only felicitous in faultless disagreement contexts when the adjective is in the positive form (88). This is because these adjectives do not exhibit scalar variation, and the disagreement concerns the threshold for the property that corresponds to the adjective. Any adjective that did not exhibit scalar variation was sorted into this class. Examples include *tall/short, hot/cold* and *fast/slow*.

(88) a. A: Tom is tall.
B: No, he is not tall!
b. A: Tom is taller than James.
B: #No, James is taller than Tom.

The TOUGH-class corresponds to adjectives that are able to participate in the *tough*-alternation; that is, they are able to be found with either an expletive subject or an NP subject and an infinitival clause, with the subject interpreted as the object of the embedded clause. Examples of adjectives in this class include *tough, easy, difficult, fun, dangerous*.

(89) a. It is tough to solve this problem.
b. This problem is tough to solve.

The SMART-class consists of only adjectives that may appear in the Evaluative Control (EC) construction, which displays a similar alternation as in (90), but the NP subject of the matrix clause is interpreted as the subject of the infinitival. Adjectives in the SMART-class are a subset of those in the TOUGH-class, since these adjectives may appear in both tough-constructions and EC constructions. The reverse is not true; most adjectives in the TOUGH-class cannot be used in EC. Categorization is determined via this criteria, and not

based on the status of the subject found with each individual adjective. This is a relatively small class, and consists of adjectives like *nice, smart, dumb, brilliant, clever* and *foolish*.

(90) a. It is smart (of Mary) to take the train.
b. Mary is smart to take the train.

Adjectives that are compatible with infinitival clauses, but do not take expletive subjects, are classified as belonging to the PRETTY-class (91). Examples include *pretty, beautiful, lovely, amazing*.

(91) a. This dress is pretty to wear.
b. *It is pretty to wear this dress.

Lastly, those in the TASTY-class are subjective adjectives that require a thematic subject, and thus do not participate in an alternation as in (89-90) above. Infinitival clauses are not required and are (for at least certain adjectives) degraded or not possible (see Bylinina 2014). Adjectives in this class include *tasty, yummy, delicious, funny* and *silly*.

(92) a. This soup is delicious (to eat).
b. ?These peppers are spicy to taste.

Syntactic environments were also categorized for ease of analysis. Full CPs without complementizers, *where*-clauses, *because*-clauses, and *if*-clauses were all simply labeled as clauses. However, infinitival clauses, *that*-clauses, *than*-clauses, and *as*-clauses are separated into their own categories. I grouped together MPs and NPs, and separated out NPs that were found in a larger phrase, namely *for*-NPs, *than*-NPs, *like*-NPs, and *as*-NPs. Certain elements formed their own category: *too* and *enough*. All adverbials are collapsed in a single category.

Beyond sorting these elements into categories, these were also coded with respect to

their position to the adjective. Taking the adjective as the anchoring point (0), anything before the adjective was in position -1, any constituent to the immediate right to the adjective was in position +1, with additional options for constituents that are +2 and +3 positions from the adjective. For example, in (93), there are two elements after the adjective *bad*: a for-NP directly after it, followed by a that-clause in the +2 position. Another example is found in (94), with an intensifier before the adjective. This system of coding enabled analysis of both the immediate syntactic environment, as well as "long(er)-distance" syntactic dependencies.

(93) **bad** for something (+1) that came out of a machine (+2) (FAT, Clark, file 2125a, line 232)

(94) awfully (-1) **big** mouse (+1) to ride on that reindeer (+2) (MOT, Suppes, file 020305, line 52)

4.2 Corpora Results and Patterns

The total number of adjectives, along with all adjective types, returned for each class is found in Table 4.1. The most frequently produced adjective types for each category are also listed.

Table 4.1: Adjective Frequencies by Subcategory

Adjective Class	# of Tokens	Frequent Types
TOUGH	7504	*good/better, bad, great, hard*
SMART	1946	*nice*
TASTY	1808	*funny*
PRETTY	1770	*pretty, lovely*
TALL	10923	*little, big, wee, long, old, hot*
Other	13191	*new, right, same, sure, last, red, ready, alright*
Total	37142	

Focusing first on what is found before the adjective (in -1 position), Table 4.2 illustrates the proportion of elements found with each adjective class.

Beginning with adverbs, we find that these are found with all of the adjectival cat-

Table 4.2: Distribution of Modifiers in -1 Position by Adjective Category

Category	TOUGH	SMART	TASTY	PRETTY	TALL	Other
Adverb	30% (904)	10% (319)	8% (249)	5% (144)	23% (696)	24% (727)
Too	14% (108)	0% (3)	1% (11)	1% (4)	73% (578)	11% (83)
How	7% (11)	7% (11)	2% (4)	7% (12)	71% (116)	6% (9)
Exclam.	15% (18)	17% (20)	25% (29)	19% (23)	17% (20)	7% (8)
MP	0% (0)	0% (0)	0% (0)	0% (0)	100% (22)	0% (0)

egories, which is not surprising given that there are no syntactic restrictions on adverbs with subjective and non-subjective adjectives. As the intention had been to code syntactic information, as opposed to semantic, particular kinds of adverbial modifiers were not separated into subcategories based on fine-grained semantic differences. Considering the specific adverbs tagged, the set of adverbial modifiers is not homogeneous; there are adverbs that are felicitous with relative gradable adjectives with open scales (e.g. *so, very*), and those that are felicitous with absolute gradable adjectives with closed scales (e.g. *completely, all*). As mentioned, absolute gradate adjectives (such as *wet/dry, clean/dirty*) were included in the non-subjective (Other) category. Semantic information is thus needed to reveal patterns that are not highlighted with the syntactic environments in Table 4.2 alone. However, we do find that *too* and *how* are found predominately with with the TALL-class, accounting for 73% and 71% of the adjectives in these syntactic environments. Comparing the proportion of TALL-class to non-TALL-class adjectives, this distribution is significant ($\chi^2(1) = 892$, $p < 0.01$). Measure phrases are exclusively found with the TALL-class, consistent with grammar. The exclamatives (*what a/such a*) are found to be fairly evenly distributed, though more common with the subjective adjectives. These observations are also reflected in the most frequent adjectives found with each of these elements (Table 4.3).

Turning next to the syntactic environments after the adjective, the constituents in either [+1] or [+2] position, additional patterns are revealed. Adjectives in the TOUGH-class account for 34% of the infinitival clauses for the subjective adjectives. As previously mentioned, SMART-class adjectives are a subset of TOUGH-adjectives; if we compare these two classes to the rest, we notice around 40% of the infinitival clauses are with these two

Table 4.3: Most Frequent Adjectives with [-1] Modifiers

Adverb	Too	How	Exclamative
good	big	old	funny
nice	small	big	nice
big	bad	long	good
funny	little	nice	pretty
hard	long	pretty	big

classes. Most adjectives are not found with infinitival clauses, considering that there are almost 10,000 tokens for TOUGH/SMART. Nevertheless, in spite of there being only 278 with infinitival complements, the proportion of TOUGH/SMART adjectives with an infinitive to those in the Other (non-subjective) category (which accounts for 43% of the infinitival clauses) is in fact significant ($\chi^2(1) = 9$, $p < 0.01$). The distribution of infinitival clauses with TOUGH/SMART adjectives relative to all other adjectives is also significant ($\chi^2(1) = 79$, $p < 0.01$).

Table 4.4: Distribution of Elements in [+1/2] Position by Adjective Category

Category	TOUGH	SMART	TASTY	PRETTY	TALL	Other
INF	34% (234)	6% (44)	1% (9)	1% (7)	14% (98)	43% (301)
Too+INF	6% (5)	0% (0)	0% (0)	0% (1)	86% (70)	6% (5)
NP	29% (93)	8% (26)	11% (35)	0% (4)	20% (66)	31% (100)
NP+INF	31% (31)	12% (11)	10% (10)	1% (1)	17% (17)	31% (31)
Enough	15% (21)	0% (1)	0% (5)	0% (0)	68% (98)	13% (19)
Clause	14% (46)	2% (6)	1% (3)	1% (5)	9% (30)	73% (245)
That-Clause	20% (17)	5% (4)	2% (2)	0% (0)	12% (10)	61% (52)
Than-Clause	23% (7)	0% (0)	3% (1)	0% (0)	65% (20)	10% (3)
As...As+XP	16% (22)	1% (2)	0% (1)	0% (1)	52% (74)	29% (41)

The adjectives in the TALL-class also surfaces with infinitival clauses. Although these are generally incompatible (see (95) below and discussion in Chapter 3), we observe that there is an almost complete co-dependency with *too* and a *to clause* with this class; 70 of 98 of all tokens of a TALL-class adjective with an infinitive are proceeded by *too*. The distribution of TALL-class adjectives with *too* and an infinitival (relative to those with just an infinitival) compared to all adjectives not in the TALL-class is also significant ($\chi^2(1) = 448$, $p < 0.01$).

(95) Tobias is tall to play basketball.

This pattern thus seems to correspond to a frame with a long-distance dependency associated with the TALL-class (96). An adjective in the TALL-class may surface with an infinitival clause, but almost always surfaces with *too* when it does. This supports the idea that it is the degree head *too* that licenses the infinitival clause with these adjectives, and that the adjective is not selecting for these clauses directly (contra the TOUGH-class). Assuming that this is a frame that learners are tracking, this indicates that surface patterns in the input reflect deeper properties of the grammar. Just as the TALL-class was found most often with *too*, it is also the class that predominately surfaces with *enough*. These environments are of course consistent with all gradable adjectives, which select for degree heads, but seem to favor these unidimensional adjectives.

Additionally, adjectives in these corpora are not always found directly before an infinitival clause, but rather select for an NP, which is in turn followed by an infinitival (96-97). I have coded this string as containing two adjacent syntactic environments (NP at +1 position, infinitival at +2) because I assume that (i) the NP and the infinitival clause belong to separate constituents, and (ii) learners are chunking constituents rather than surface strings (though I do not assume that the infinitival clause is represented in the syntactic structure in the same way for all adjectives/constructions, in part due to differences in the (non)-obligatory status and semantic contribution of these clauses). Previous research has found that children are sensitive to constituent structure (see e.g. Lidz, Waxman & Freedman 2003; Takahashi 2009), thus there is reason to believe that learners would be equipped with knowledge of phrases when analyzing the environment after the adjective. Nevertheless, the numbers for this environment are quite low. Comparing the proportion of adjectives followed by an NP to those followed by an NP and an infinitival (NP + INF), there are no significant differences in distribution, meaning that the syntactic environment NP + INF is not associated with any particular adjective class.

(96) a. [[ADJ [NP [INF]]]

b. [easy [game [to play (game)]]]

(97) Because that's a nice place to go. (MOT, Brown- Adam, file 031101, line 1414)

Other post-adjectival indicators include clauses and that-clauses in particular; more than half of all *that*-clauses (60%) are found with adjectives that do not belong to any of the five subcategories considered here. An exception to this pattern comes from *than*-clauses, which are predominately found with the TALL-class; 20 of 31 than-clauses are found with one of the adjectives in this TALL-class. The numbers for all clause types are also low, but these patterns suggest that different clause types favor different subcategories: infinitival clauses are more frequent with TOUGH/SMART, *than*-clauses are rare, but more likely to surface with TALL, and other (finite) clauses favor other, non-subjective adjectives. Adjectives in the TALL-class is also more likely to surface in an equative construction as (98), where here XP stands for either a clause or an NP. Conversely, an adjective from the SMART/TASTY/PRETTY-class are highly infrequent in this context.

(98) [as ADJ [as [XP]]]

Lastly, as mentioned we had considered *for*-phrases and *of*-phrases. The results for the distribution of these complements are found in Table 4.5 below.

Table 4.5: Distribution of *For*- and *Of*-Phrases by Adjective Category

Category	TOUGH	SMART	TASTY	PRETTY	TALL	Other
For-NP	34% (105)	3% (10)	4% (12)	1% (3)	34% (105)	23% (70)
Of-NP	5% (7)	28% (38)	1% (2)	0% (0)	6% (8)	59% (80)

These frames are infrequent, but particular patterns nevertheless emerge. We find *for*-phrases with both the TOUGH and TALL-class. This is consistent with what is known about their semantics. For instance, the TOUGH-class selects for an experiencer argument that is able to be expressed overtly via a for-phrase, as is found in the example in (99).

Although similar in distribution, for-phrases with TALL-class adjectives are often comparison classes, as in (100). That said, given the proportions of *for*-NPs produced given the size of the two classes, the TOUGH-class is more likely to be found with a *for*-NP than the TALL-class ($\chi^2(1) = 7, p < 0.01$).

(99) easier <u>for us</u> (PAT, Bloom-Peter, file 020118, line 10424)

(100) too big <u>for soldiers</u> (MOT, Wells-Elspeth, file 020229, line 295)

The *of*-NP frames are found comparatively more often with the SMART-class than the other classes of subjective adjectives, which is what is expected based on the evaluative control construction. It should be noted that all of the tokens of this frame found in these corpora happen to feature the adjective *nice*, as in (101). We also find *of*-NPs with the Other category, where these surface with emotion adjectives like *afraid, proud* and other gradable adjectives like *full*.

(101) That was very nice <u>of you</u>. (MOT, Brown-Adam, file 040401, line 3017)

4.3 Discussion

Taking the patterns from the corpus-analysis into consideration, there are certain syntactic environments that are consistent with particular adjectival categories. First, we find that adjectives in the TALL-class surface in environments with *too* and an infinitival. This is consistent with the grammar– putting aside functional standard constructions (see (102a), which seems to be interpreted in much the same way as *too*-constructions (102b); Bylinina 2012), TALL-class adjectives do not select for infinitival clauses. However, *too* is able to select for the infinitival, forming a non-linearly-adjacent constituent in a DegP and combining with adjectives like *tall* that would not normally surface with infinitival clauses on their own. If the learner is guided by phrase structure, a core assumption of syntactic bootstrapping, then long-distance dependency here should correspond to a frame that is compatible

with the TALL-class.

(102) a. John is a bit tall to ride this roller coaster.

b. John is too tall to ride this roller coaster.

Frequency-based information additionally seems to interact with the frame. Although *too* + INF is not exclusive to the TALL-class, the distribution here suggests that learners should be more likely to assume that an adjective belongs to the TALL-class given this frame. If assumptions about the grammar are combined with statistical patterns, then they may be more likely to associate this frame with TALL. Similarly, *than*-clauses (though rare in these corpora) are more common with the TALL-class. These clauses are semantically informative as they provide a standard of comparison, and are compatible with gradable adjectives, the only adjectives that select for these clauses. Among gradable adjectives, the data again reveals that the TALL-class is more likely to be found in this frame. The previous frames are compatible with the TALL-class, but also consistent with other categories. On the other hand, measure phrases are exclusive to the TALL-class, and indeed measure phrases are only found with this class in the corpora consulted.

Next, the TOUGH/SMART-class is found with infinitival clauses proportionally more often than other adjective classes. Given the semantics of these adjectives, this finding is not unexpected. These adjectives select for an event, which is provided by this infinitival clause. None of the other categories obligatorily select for an event. Although PRETTY-class adjectives may optionally select for infinitival clauses, these adjectives are compatible with both individuals and events. The fact that the distribution of infinitival clauses favors the TOUGH/SMART-adjectives seems to reflect this distinction between these adjective types. On the other hand, non-subjective adjectives are found significantly more often with finite clauses. Lastly, we saw that certain adjectives were more likely to select for a *for*-phrase and *of*-phrase; the former are both (relatively) more common with TOUGH and TALL, with TOUGH-class adjectives being more likely to select for these phrases than

TALL-class adjectives. Although the overall numbers of *of*-phrases is quite small, there are trends in their distribution, with both the SMART-class as well as the non-subjective adjectives.

Although certain classes are distinguished by the their distribution relative to the syntactic environments considered here, others are not. The adjectives in the TASTY and PRETTY-class rarely surface with anything to the right of the adjective (any of the elements in the [+1] position). The adjectives in the PRETTY-class in particular account for just 0-1% of these elements found in the input. In other words, these classes are characterized not by what they select for, but rather what they do not select for here. This is also consistent with what is known about their syntax and semantics. Recall in our classification for these adjectives, those in the TASTY-class was identified in part by their (relative) incompatibly with infinitival clauses. Thus, not finding these adjectives in particular syntactic environments is arguably a signature reflected in the data as well.

This is a caveat with these results. Considering the low frequencies of the syntactic environments considered, most of the adjectives across the subcategories of interest are not found in these environments. The consequence of this is that while the learner encounters frames that are in fact indicative of particular categorizations, there is also arguably considerable "noise" in the form of indistinguishable frames, e.g unmodified adjectives in pre-nominal or predicative position, which do not favor any particular adjective and are thus unhelpful for learning. Nevertheless, there is reason to believe that learners are able to extrapolate categories from limited data in the input. For example, Becker (2014) reports that tough-adjectives are rare in the input in the corpora that she consulted, consistent to what is found here (about 7,500 instances to more than 37,100 total adjectives), but that in her sample these adjectives were nevertheless found more often with inanimate subjects (see Table 4.6 reproduced from Table 6.2 in Becker (2014)).[2] Although there are only 116 tokens of *tough*-adjectives, the asymmetry supports a category-based distinction based

[2]This percentage excludes counts of expletive subjects.

on animacy. Becker (2015) additionally conducted research on children's interpretation of tough-adjectives, manipulating animacy, and found that children did rely on animacy as a cue for learning *tough*-adjectives– even though such predicates are rare in the input.

Table 4.6: Distribution of Animate/Inanimate Subjects from Becker (2014)

Tough-Adjective	Animate Subj.	Inanimate Subj.	% Inanimate
hard	2	93	
difficult	0	3	
easy	1	17	
tough	0	0	
total	3	113	97.4%
Control-Adjective			
happy	8	0	
afraid	7	0	
anxious	2	0	
willing	1	0	
glad	14	0	
eager	0	0	
total	0	0	0%

Nevertheless, unlike subjects, which are always required in English (with certain exceptions, such as fragment questions/answers), adjectives do not require adverbs or overt clauses or judges. The result is that the bare form of these adjectives (those without any modification) will always outnumber those in one of these informative frames. If children are relying on frames for learning, they need to be able to recruit these frames when they do surface. Previous research indicates that this is possible. Syrett (2007) found that adverbs, which are informative to category membership with respect to relative vs. absolute gradable adjectives, are rarely found in child-directed speech (again consistent with the results here); Syrett reports that more than 60% of the adverbs found in the Brown and Suppes corpora are not modifying adjectives. In spite of the limited corpus data, Syrett (2007) found that in a word-learning experiment with novel adjectives, children responded differently depending on the adverb that was presented with the novel adjective. Children interpreted the adjective as a relative gradable one if the adjective was e.g *very*, but as an absolute gradable adjective when the adverb was *completely* instead. Thus, in spite of the

low frequency of adverbial modification in the input, children were still successful at recruiting adverbs when determining the meaning of novel adjectives. Following previous results such as these, it is reasonable to suspect that learners may be able to equally rely on the syntactic environments investigated here for the purpose of categorization.

4.4 Conclusions

In this chapter, I discussed the results of an investigation into adjectives, both subjective and non-subjective, and their frames in the exposure language, considering a range of corpora. Analysis of these corpora yielded several findings that point to reliable patterns in terms of how adjectives cluster together with particular frames. We found that while adjectives most often surface without modifying adverbs or standards/complements, when they are found with these elements patterns emerge that reflect known syntactic and semantic categorizations. This chapter has thus attempted to answer the first of two questions addressed in this dissertation: Is there information in the input that would enable the learner to recognize and (sub)-categorize subjective adjectives? The answer to this question is yes. However, it is yet to be determined if learners are actively paying attention to this information, and if they are tracking frames in order to determine word meanings. Given the limited data available, it is especially critical to determine if learners are in fact able to "bootstrap" meanings of subjective adjectives with syntactic information alone.

In order to address the second question, I present the findings from a word learning experiment in Chapter 5. To preview the discussion from this chapter, I argue that learners rely on where a given adjective is found across frames, and that they use this information to deduce the "strongest candidate" in terms of its meaning, consistent with the multiple frames hypothesis for verb learning (Naigles 1996; Mintz 2003).

CHAPTER 5
WORD LEARNING

Syntactic bootstrapping is the theory that children are able to recruit syntactic information (frames) to learn the meaning of novel words. This is based on the fact that there is a reliable mapping between syntax and semantics, such that the syntactic environment helps the learner narrow down the range of plausible meanings based on expectations about selectional restrictions. Previously in Chapter 2, I discussed that the exact frames that children are relying shifts as a consequence of what they are learning, as different frames are associated with different categories and subcategories. For instance, when children are learning verbs, they expect participants to map to arguments, and know that verbs with more than one argument are transitive verbs. In much the same way, subjective adjectives are also associated with particular syntactic frames, as discussed in Chapter 3; I argued that these frames should help children learn the different types of subjective adjectives, if syntactic bootstrapping proceeds in the same way in the adjectival domain as it does in the verbal and nominal domain. For bootstrapping to succeed, however, there must be frames that support categorization in the input that the child receives. Previously in Chapter 4, I examined child-directed speech to determine the nature of this input, specifically to determine what kinds of frames cluster with the subjective adjectives that I am focused on in this dissertation: the TALL, TASTY, TOUGH, PRETTY, and SMART class. I found that the distribution of frames in the input reveals particular patterns, in terms of which frames are associated with a given class(es). Some of the frames were associated with the entire category of subjective adjectives (e.g. *really, very* + ADJ), while others were specific to one of the classes (e.g. *too* + ADJ is a frame found predominantly with TALL, whereas ADJ + *to* clause is a frame found predominantly with TOUGH). I concluded that information is available that would help the acquisition process.

This dissertation began with two fundamental questions about word learning: What frames are available that would in theory guide learning and categorization? And, are learners sensitive to these frames? The corpus results provide insight into the first question, but it is yet to be determined if learners are recruiting these frames. In this chapter, I ask if learners are sensitive to syntactic information when learning novel adjectives. I address this question by discussing a word learning experiment that is carefully designed to replicate the acquisition process. To preview the results, I show that participants are in fact sensitive to syntactic information. When prompted to guess the meaning of novel adjectives, having only syntactic frames to rely on, participants provided subjective adjectives, and made a distinction between classes, as they responded differently depending on the set of frames provided to them. This chapter is set up as follows: in Section 5.2, I present the experimental design for the word learning study. In Section 5.3, I detail how data from the experiment was coded and analyzed. In Section 5.4, I discuss the results before offering conclusions.

5.1 Experimental Design and Participants

5.1.1 Participants

423 adults participated in this study. These participants were recruited online, from Prolific, and from the Rutgers University undergraduate subject pool for linguistics research. Prolific participants received a small payment (between $3 and $3.50) for compensation, and SONA participants received extra credit. We recruited native English speakers in this experiment. An additional 26 speakers had to be excluded for being a non-native speaker of English, 11 for not spending enough time on the task, 10 for missing too many questions, not completing the task/completing it twice, or not understanding the task, and one for missing both of the attention checks embedded in the design.[1] Of the 27 non-native speakers, 12 were accidentally able to sign up for the experiment due to an error with posting on

[1]Participants were told that they needed to spend 10 minutes on the task. While we included those just under this limit (9 minutes), those who spent 8 minutes or less on the study were excluded. The participant who was excluded for not understanding the task explicitly indicated in her responses that she was confused.

Prolific.[2]

5.1.2 Materials

We recorded the videos for this experiment with the help of two undergraduate research assistants from the Rutgers Laboratory for Developmental Language Studies. These research assistants assumed the part of Speaker A or Speaker B for every video. These videos were recorded in a quiet office space, with a plain white background. Nothing else is visible within the scene. Videos were uploaded into iMovie and sliced into clips of approximately 10-15 seconds in duration. All clips were given an alphanumeric code and uploaded to YouTube, and subsequently embedded into a survey in Qualtrics.

5.1.3 Procedure and Representative Trial

The word learning experiments are modeled after the Human Simulation Paradigm (HSP), pioneered by Gillette et al. (1999) and further extended by Kako & Gleitman (2004) and Snedeker & Gleitman (2004). Participants are asked to determine the meaning of a mystery word. As in earlier studies (see Arunachalam & Waxman 2010; Arunachalam et al. 2012; Yuan & Fisher 2009), this experiment has a dialogue format. The HSP is designed to be run with adults, but intended to replicate (simulate) the acquisition process; the benefit of this experimental design is that adults can be directly asked to respond to prompts (particularly online, as is the case here). Running the experiment on adults also avoids issues with vocabulary size and conceptual development, which would need to be controlled for with child participants. The HSP is also an initial attempt to capture word learning; if adults are unable to learn from the syntactic frames provided, it is unlikely that children would be able to. The research will eventually be extended to include children in a modified version of this same task.

[2]The number of participants excluded does not include anyone who signed up but then "returned" the experiment (decided, either before or during the study, not to participate)– an option that Prolific allows.

In each trial of this experiment, participants watched video clips of two speakers having a conversation using a mystery word (a target adjective) in four different informative frames. They were then prompted to provide a guess for the meaning of the target word, as well as a confidence rating along a four-point scale (from *not at all confident* to *very confident*). Videos were sliced into clips, and each clip featured the target adjective in a unique frame. The target adjectives corresponded to the five classes of subjective adjectives highlighted in Chapter 3 (*tall, tasty, tough, pretty, smart*), with the set of frames being consistent with at least one of these five classes. The trial sequence for each item is illustrated in Figure 5.1.

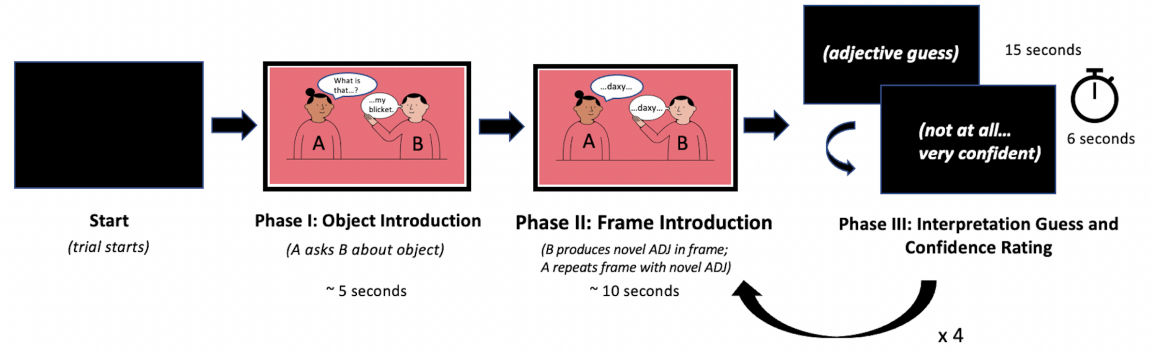

Figure 5.1: Trial Sequence

There were four conditions, and all conditions had a between-subjects design. In the first condition, each participant saw only one set of target frames (e.g. the set of frames corresponding to *tasty*) and four control items. There were thus five sub-conditions, in order to balance the number of participants who saw each frame set. In the second condition, each participant saw all five sets of adjective frames with no controls. In both conditions, participants were prompted to provide a guess and a confidence rating after each individual video clip. They were instructed that they could change their response (or not) as they saw fit, as they proceeded, based on the video clips. These incremental conditions enabled participants to revise their guess as they received more information– specifically, more frames– over time, consistent with Piccin & Waxman (2007).

Two additional conditions mirrored the first two, except that participants provided their guess and their confidence rating at the end of the set, and not after each individual frame. The form of the target adjective in these conditions was always the same (*daxy*) in conditions where the participant received only one set of target frames. In the conditions where participants saw more than one set of frames, the adjective differed (*daxy, wilpy, spoovy, brispy, gloopy* along with the frames. Participants in all conditions could watch the videos as many times as they wanted before progressing to the next trial, but they could not return to a video after continuing on. The transcript for the video was also provided for them below each video to avoid any confusion about what was said in the dialogue. This study was timed; participants were required to provide their guess within 15 seconds and their confidence rating within 6 seconds. The reason for timing participants was to discourage them from overanalyzing their responses, and to get their initial reactions. Participants were also provided with explicit instructions informing them that they needed to provide a single, one-word response, and were told that they needed to provide a contentful response (an actual guess, instead of responding e.g. *an item* or *an adjective*).[3]

The videos for the target adjectives all began in the same way: Speaker A asked about an object (not shown) and Speaker B responded by labeling the object with a novel noun (*blicket, bosa, heach, tulver, greeb*). Speaker A then repeated the novel noun, and Speaker B responded in such a way as to reinforce that it is an inanimate object under discussion, but offering no other context clues that would bias the participant into assuming a particular meaning. For example, Speaker B said something about where she got the object or who gave it to her. This concluded the introductory phase. At this point, the first frame was introduced with the target adjective. Speaker B always introduced the frame, and Speaker A repeated it each time, so that participants heard the same frame twice. Each frame corresponded to an individual clip, such that participants would be exposed to these frames

[3]These instructions are the result of an earlier pilot study for this experiment, in which participants often provided vague guesses or multiple responses. While not all of the participants followed these updated instructions, most of them did.

over the course of the trial. While any one frame may not be informative enough on its own, the set of frames should signal a subcategory of subjective adjectives. An example of a full representative trial for the TOUGH-class is found below.

Table 5.1: Representative Trial (Tough)

Introduction	Test Phase (Frames)	Prompts
		
A: What is that on the shelf? B: That is a bosa. A: Oh, that is a bosa? B: Yeah, I got this bosa from school.	B: You know, it is daxy to fott this bosa. A: Oh wow, it is daxy to fott this bosa.	What does DAXY mean? How confident are you in your response? (omitted for single/final guess conditions)
	B: Yeah, fotting this bosa is so daxy! A: Mm hmm, fotting this bosa is so daxy!	What does DAXY mean? How confident are you in your response? (omitted for single/final guess conditions)
	B: And bosas are daxy for us to fott. A: Oh yes! Bosas are daxy for us to fott.	What does DAXY mean? How confident are you in your response? (omitted for single/final guess conditions)
	B: Indeed, fotting bosas is daxy for us. A: I hear you. Fotting bosas is daxy for us.	What does DAXY mean? How confident are you in your respnse?

(103) a. It is daxy to gorp this blicket. **Good**

b. It is daxy for us to gorp blickets.

c. It is very daxy for us.

d. Gorping blickets is daxy to do.

(104) a. He says heaches are not daxy, but I think heaches are really daxy. **Tasty**

b. I think this heach is so daxy.

c. To me, this is such a daxy heach.

d. I find this heach to be very daxy.

(105) a. She thinks tulvers are not daxy, but I think tulvers are really daxy. **Pretty**

b. This tulver is daxy enough to zeb.

c. I consider this tulver to be very daxy!

d. What a daxy tulver!

(106) a. This greeb is very daxy for a greeb. **Tall**

b. This is such a daxy greeb!

c. This greeb is 2 chopanis daxy![4]

d. This greeb may be too daxy.

(107) a. It is daxy to fott this bosa! **Tough**

b. Fotting this bosa is so daxy!

c. Bosas are daxy for us to fott.

d. Fotting bosas is daxy for us.

5.1.4 Practice and Control Items

Every session began with a practice item (*cheem*), which corresponded to a 'belief' verb with a clausal complement (e.g.*think, know*). This was to acclimate them to the task and to

[4]The novel unit of measurement 'chopani' is taken from Arii et al. (2017). Although participants had the script in front of them, a potential confound comes from the use of the number two, which is homophonous with 'too', which may have caused some unintended confusion.

be clear about what was expected of them (one word guesses based on the frame). Participants received feedback after each of their guesses during this practice trial, the frames for which are in (108).

(108) a. The girl cheems that the tanzer smopped.
b. The tanzer smopped, and somehow the girl cheems that the tanzer smopped.
c. The girl cheems about it.
d. I don't know how she cheems that.

There were four control items. Two of the control items corresponded to novel nouns, one count and one mass. These nouns also appear in distinct frames, and are distinguished via morphosyntactic information. The former refer to discrete, countable objects and as a result surface with plural morphology, determiners such as *more/many* and numerals. The latter refers to non-discrete substances, and thus surface in different environments; for example, as these nouns are not countable, they are not compatible with plural morphology, and agree with the verb in its singular form. The specific frames included for these items are found below. Previous research indicates that children are capable of distinguishing between count and mass nouns, and appropriately categorize objects based on the frame that the novel noun is found in (those equivalent in nature to (109-110)) (Brown 1957; Soja et al. 1991; Soja 1992).

(109) a. These are modis. **Count Noun**
b. I have one, two, three modis!
c. There are more modis over there.
d. I could have so many modis!

(110) a. This is some foom. **Mass Noun**
b. I have a lot of foom.
c. There is too much foom.

d. There is less foom over there.

Two other control items corresponded to novel verbs, one that selects for a direct object and one that selects for a clausal complement. Verbs are categorized based selectional restrictions that reflect the semantics. Those that select for a direct object (simple transitive verbs such as e.g. *kick, hug*) describe an action between two participants, where the object is interpreted as the recipient of the action. Those that select for a clausal complement (sentential verbs such as e.g. *think, know, say*) express a proposition, and that proposition corresponds to the clause. Studies have illustrated that learners are able to track syntactic information, and pay attention to the number of arguments to distinguish simple transitive and intransitive verbs (Fisher et al. 1989; Gleitman 1990; Gleitman et al. 2005; Yuan & Fisher 2009; Yuan, Fisher & Snedeker 2012; among others), and the complement type to subcategorize appropriately (Papafragou, Cassidy & Gleitman 2004; Becker & Estigarribia 2013; Harrigan, Hacquard & Lidz 2016). In other words, it was expected that participants would be able to recruit syntactic information to determine the meanings of these control items. The frames for these control items are below (see Appendix A for the full script for all experimental items).

(111) a. The boy is going to roak the tami. **Transitive Verb**

b. The tami will be roaked by the boy.

c. The boy is going to roak the tami with the husp.

d. The boy is going to roak the tami with the husp slowly.

(112) a. The girl pilks that the lorp is gonna ziff. **Sentential Verb**

b. She pilked that to me yesterday.

c. The lorp is not gonna ziff, but the girl pilks that the lorp is gonna ziff.

d. I don't know why she pilked that.

The presentation of items was pseudo-randomized, such that participants in the single ad-

jective conditions saw two control (one noun, one verb) items before the target item, and two control items after. In the two conditions featuring all adjectives, participants received only target trials after the practice item. The presentation was counterbalanced; half of the participants in these conditions also received the trials in one order, and half of them received the trials in the reverse order. Participants were randomly assigned to each condition.

5.2 Scoring

5.2.1 Frame Compliance

Participant responses were analyzed based on frame compliance. This was determined in two ways: first by determining whether or not their response fits with the entire set of frames provided, and then, by determining if the response fits the intended category of the item (noun, verb, adjective). For the conditions in which participants guessed at the end, only one guess was provided, and compliance was based on this single guess relative to the entire frame set. The guess had to match all four of the frames (as opposed to the final frame, or most of the frames) in order to be coded as compliant. If the guess was inconsistent with one or more frames, it was coded as non-compliant. Examples for *daxy/gloopy* (the TALL-class) are found below. In this case, a guess like *big* is frame compliant as it fits in all four frames; although *pretty* is consistent with most of the frames in the set, it is not compatible with measure phrases (113c), resulting in the adjective guess being coded as non-compliant.

(113) guess: *big*

a. This greeb is very daxy/gloopy for a greeb.

b. This such a daxy/gloopy greeb.

c. This greeb is 2 chopanis daxy/gloopy.

d. This greeb may be too daxy/gloopy.

(114) guess: *pretty*

a. This greeb is very daxy/gloopy for a greeb.

b. This such a daxy/gloopy greeb.

c. This greeb is 2 chopanis daxy/gloopy.

d. This greeb may be too daxy/gloopy.

For the conditions in which participants guessed after each frame, frame compliance was also determined based on the last guess, as with the other two conditions. Although participants were told that they needed to provide a single-word response, some participants provided more than one guess. If all of their guesses were able to appear in the frame, this was coded as frame-compliant; the reverse was also true– if none of the guesses fit, this was considered non-frame compliant. Responses that included guesses that both fit and did not fit the frame were excluded for the purpose of analysis, and coded as "other".

5.2.2 Confidence Ratings

Confidence ratings were provided on a four-point scale: *not at all confident, somewhat confident, confident, very confident*. Participants' selections were later converted into a value from 0 to 3 for the purpose of analysis, which allowed me to calculate an average confidence score for each novel item. For participants in the incremental conditions, I calculated an average confidence score for both their first guess and their last guess, in order to determine if participants became more confident as they received more syntactic information.

5.3 Predictions

First, for the control items, we expected participants to provide primarily frame-compliant responses, and be confident in their responses. For the test items, we predict the following. If participants are sensitive to frame information, in the same way that they are to those for

nouns and verbs, they should be able to use this information to narrow down the hypothesis space of potential meanings, arriving at a guess that is compliant with the frames. Because there is considerable overlap in the frames that subjective adjectives may appear in, we anticipate that those in the incremental conditions might change their guess as they progress, and become more confident about their guess, if they receive more information that either confirms or rules out their previous guess. If participants are not able to rely on frame information, then they may provide guesses that are either not compliant with the frames, or that reflect sensitivity to grammatical category but not subcategory. If participants are able to recruit specific frame information, guesses should be consistent with the subcategory of interest. If participants are sensitive to certain frames, but not others, then performance should vary depending on the adjective class in question. That is, each set of frames is categorized by syntactic information that should favor a particular subcategorization. However, syntactic bootstrapping is only possible if leaners are aware of the connection between a frame and a given meaning. If they are unaware of this connection for a certain frame, this means that this frame will be unhelpful for learning.

5.4 Results

5.4.1 Frame Compliance: Controls

Frame compliance results for the control items are reported below, first by condition (incremental guessing vs. guess-at-the-end) in Table 5.2, and then collapsed across conditions in Table 5.3. Participants in the conditions with all adjectives did not receive control items, and thus these conditions are not included in this analysis here.

Table 5.2: Frame Compliance (Controls) By Condition

Item	Category	Incremental Guessing	Guess-at-the-End
Modi	Count Noun	96%	95%
Foom	Mass Noun	88%	92%
Roak	Transitive Verb	98%	94%
Pilk	Sent. Verb	77%	64%

Table 5.3: Frame Compliance (Controls) Across Conditions

Item	**Category**	**Percentage Compliant**
Modi	Count Noun	96%
Foom	Mass Noun	90%
Roak	Transitive Verb	96%
Pilk	Sent. Verb	71%

Participants were near ceiling for most of the control items, specifically the novel nouns and the simple transitive verb. The exception comes from the novel sentential verb (*pilk*); participant guesses were often of the right category (other verbs that take clausal complements), but not all of them were compliant with the set of frames. There are different subcategories within the set of sentential verbs, and *pilk* was consistent with a verb or reporting (*say*) but not e.g. a belief verb (*think, believe*); a common error was providing a response compliant with the intended category, but not with the set of frames.

5.4.2 Confidence Ratings: Controls

Confidence ratings for the control items are found in Table 5.4. There are two main observations from this data. First, participants in the incremental condition overall become more confident in their guesses as they progress through each of the trials. The exception to this is with the mass noun (*foom*). Second, although participants overwhelmingly provided frame compliant responses, confidence ratings are low.

Table 5.4: Confidence Ratings (Control Items- Single Adjective Conditions)

Condition	Item	First Guess	Last Guess	
incremental	Count N	0.39	0.61	$p < 0.05$
final		–	0.50	
incremental	Mass N	0.78	0.57	$p < 0.05$ [5]
final		–	0.50	
incremental	Trans. V	0.47	0.78	$p < 0.05$
final		–	0.75	
incremental	Sent. V	1.18	1.90	$p < 0.05$
final		–	1.61	

5.4.3 Frame Compliance: Targets

For the target adjectives, we compared performance across conditions and within each condition, considering the final guess provided. Looking at the results (Table 5.5), we find that participants consistently provided compliant responses for the adjectives corresponding to TOUGH, SMART, and TASTY. They additionally performed better with these three adjectives classes than with either PRETTY or TALL.

Table 5.5: Frame Compliance (Target Items)

	Incremental		Final Guess	
ADJ Category	**Single Adj**	**All Adj**	**Single Adj**	**All Adj**
Smart	91%	92%	85%	80%
Tough	90%	86%	80%	79%
Tasty	91%	93%	87%	81%
Tall	50%	61%	47%	30%
Pretty	88%	81%	89%	63%

These results were analyzed with a mixed effects logistic regression model, with three independent factors: Adjective (with five levels corresponding to the five subcategories), Format (with two levels (Single ADJ, All ADJ)), and Mode, (with two levels (Incremental Guessing, Single/Final Guessing)). The Intercept for this model corresponds to SMART + Format-AllADJ + Mode-Single Guess. No Interactions (Adjective*Format*Mode) were included in this model, as including this does not reveal any significant decrease in fit as determined via an ANOVA comparing the two models ($p < 0.05$). This model reveals Main Effects of both Adjective and Mode (see Table 5.6). Participants are significantly worse ($p < 0.05$) at guessing the meaning of the novel adjective when that adjective belongs to the TALL or the PRETTY class. Participants in the conditions in which they guessed after each frame (incremental guessing) were also significantly better ($p < 0.001$) at guessing than participants in the conditions in which they had to wait to guess at the end, revealing an advantage for being able to revise in real time as more information is received. As there are no significant interactions, this also indicates that performance was not significantly

better with any particular adjective in any of the conditions.

Table 5.6: Mixed Effects Logistic Regression Model on Frame Compliance

	Estimate	Std. Error	z-value	Pr(>|z|)
(Intercept)	1.61	0.28	5.72	0.00***
Pretty	-0.76	0.31	-2.48	0.01*
Tall	-2.33	0.31	-7.45	0.00***
Tasty	0.91	0.34	0.27	0.79
Tough	-0.27	0.32	-0.84	0.40
Format-SingleADJ	0.36	0.21	1.68	0.09
Mode-Incremental	0.84	0.21	4.02	0.00***

Of the non-compliant responses to target items, 185 of them (89%) were still adjectives (Table 5.7). Only a handful of responses belonged to a different grammatical category, such as nouns (n=17). Within the set of (non-compliant) adjective guesses, more than half were also subjective adjectives (66%), as determined via faultless disagreement, and almost all were gradable (95%).

Table 5.7: Non-Compliant Responses by Type (Across Conditions)

Category	**Percentage**
Adjective	89%
Subjective Adjective	66%
Gradable Adjective	95%
Noun	8%
Other	3%

Looking at the most frequently guessed adjectives, we also see that participants are making a distinction in how they respond. The following table highlights the top five responses to each of the target items, collapsing across all conditions.

5.4.4 Confidence Scores: Targets

First, for the participants who guessed four times, the average confidence score for each adjective for the first and last guess was calculated and then compared via a pairwise t-test. The results of this comparison reveal that overall participants became more confident as

Table 5.8: Most Frequent Guesses Per Condition

Smart	Tough	Tasty	Tall	Pretty
good	fun	cool	big	cool
fun	good	tasty	small	unique
healthy	easy	pretty	long	useful
easy	cool	beautiful	large	pretty
cool	lucky	useful	tall/pretty	good
			old/sticky	

they progressed through the experiment. The change in ratings is significant for all adjectives but TALL and PRETTY in the single-adjective condition ($p< 0.05$), and is significant for those in the all-adjective condition ($p<0.05$). The average confidence scores per adjective for these two conditions are found in Table 5.9.

Table 5.9: Confidence Ratings (First vs. Last): Incremental Guessing Conditions

Condition	Adjective	First Guess	Last Guess	
single adj	Tough	0.60	1.27	$p < 0.05$
all adj		0.43	1.05	$p < 0.01$
single adj	Tall	0.78	1.03	not significant ($p = 0.08$)
all adj		0.44	0.97	$p < 0.01$
single adj	Tasty	0.97	1.63	$p < 0.05$
all adj		0.69	1.05	$p < 0.01$
single adj	Pretty	1.15	1.38	not significant ($p = 0.13$)
all adj		0.71	1.02	$p < 0.01$
single adj	Smart	0.62	1.29	$p < 0.01$
all adj		0.53	1.05	$p < 0.01$

Average confidence scores for the conditions in which participants made a single guess are found in Table 5.10 below.

Table 5.10: Confidence Ratings: Single Guess Conditions

Condition	Adjective	Confidence Rating
single adj	Tough	0.83
all adj		0.98
single adj	Tall	0.80
all adj		0.93
single adj	Tasty	1.03
all adj		0.98
single adj	Pretty	0.93
all adj		1.10
single adj	Smart	1.04
all adj		1.17

5.5 Discussion

The results from the word learning experiments yield several findings. First, participants were able to reliably use the frames to narrow down the hypothesis space of potential meanings, providing responses that were frame compliant. Although there is considerable overlap in the frames in which these adjectives are found, the set of frames prompted guesses that reveal an awareness of subcategorization. Main effects of adjective type reveal that participants were better at providing guesses for some of the subcategories. Noticeably, participants provided significantly fewer compliant responses for the TALL-class. However, it is possible that this is an artifact tied to a particular complication with one of these frames, namely the use of a (novel) measure phrase before the adjective. While this frame ruled out adjectives from other subcategories, participants needed to be able to recognize *chopani* as a measure phrase. If the set of frames is compliant with other types of subjective adjectives. Given that the most frequent guesses for this set of frames are all members of the TALL-class, participants are able to successfully recruit syntactic information to subcategorize adjectives into this class as well. Second, learners benefit from having a chance to incrementally integrate frame information as they progress, regardless of whether or not they are trying to learn a single adjective or multiple adjectives at once. This suggests that being able to revise as additional syntactic information is provided is an advantage.

Additionally, participants in the incremental conditions became more confident in their guesses to the target items as they received more information, which is consistent with successful bootstrapping. Each frame helps to narrow down potential meanings, and as participants progress through the trials, they have more information to guide them. However, confidence ratings remained relatively low, with participants only somewhat confident in their final responses to the target items (scores ranging from 0.80 to 1.63 out of 3). Participants in all conditions provided comparable ratings. Confidence may also be tied to the size of the category. Participants were not as confident with control items corresponding to novel count and mass nouns, as well as novel transitive verbs; given that there is quite a large number of nouns and verbs that would fit into these frames, I suggest that the lower confidence ratings here are an indication that participants are unsure that there guess corresponds to the *specific* word intended, rather than a lack of confidence that their guess is plausible or possible with the frames. Support for this comes from the observation that frame compliance scores remain high.

5.6 Conclusion

In this chapter, I have illustrated that learners recruit syntactic frames in order to deduce the meanings of subjective adjectives. Participants provide frame-compliant responses for the meanings of novel adjectives, having only the syntax to rely on. These findings compliment the results from the corpus research in Chapter 4; just as particular adjectives cluster with certain syntactic environments, sets of frames help learners narrow down the potential meanings for a given adjective. In Chapter 6, I will combine the results from the corpus search and the word learning experiment discussed here to motivate a proposal for learning subjective adjectives.

CHAPTER 6
LEARNING SUBJECTIVE ADJECTIVES: A PROPOSAL

This dissertation has investigated whether syntactic bootstrapping supports the acquisition of subjective adjectives. I asked: (i) Is there reliable information in the exposure language for leaners to use to bootstrap the meanings of subjective adjectives? and (ii) Can learners recruit syntactic frames to narrow down the meanings of novel adjectives? In this section, I present a proposal that unifies the results of the corpus research and the word learning experiment discussed in this dissertation that have directly addressed these two questions, which address these two questions respectively. Before doing so, I briefly review the research on syntactic bootstrapping and subjective adjectives that has grounded this research, and the main results of these studies, in order to motivate this proposal.

In Chapter 2, I reviewed the theory of syntactic bootstrapping, and how it has been able to capture word learning during the child language acquisition process. Children rely on syntactic frames found in the input to appropriately categorize words into broad categories (such as noun, verb) and specific subcategories (e.g. transitive verb, intransitive verb, raising/control verb), as has been demonstrated by numerous studies since the original pioneering work of Landau & Gleitman (1985) and Gleitman (1990). Moreover, previous research has also demonstrated that children are capable of relying on multiple frames to deduce the meaning of words (see Naigles 1996; Mintz 2003). The emphasis in the literature thus far has been on verb learning; less is known about how bootstrapping facilities learning other categories. I argued that subjective adjectives provide an ideal case study for syntactic bootstrapping in the adjectival domain, given that these adjectives do not have an observable correlate that learners could rely on, and they do not have a fixed referent, but rather are dependent on a judge. Nevertheless, these adjectives have well-defined syntactic signatures. Thus, these adjectives are precisely the type of predicate that syntactic

bootstrapping should be able to account for in terms of their acquisition.

In Chapter 3, I provided detailed different categories of subjective predicates, based on established syntactic and semantic differences in the literature. I focused on five subclasses in particular, referred to in terms of a canonical member of each class: TOUGH, SMART, PRETTY, TASTY and TALL. I argued that unlike the classic examples of word learning centered on simple transitive and intransitive verbs, subjective adjectives are crucially found in overlapping syntactic environments and as a result cannot be easily categorized based on a single frame. I explained that these are instead characterized by specific sets of frames, based in part on Bylinina (2014).

As a first step in determining if reliable syntactic information is available for learners, I analyzed the input that children receive by extracting adjectives from 44 corpora found on CHILDES, the results of which I discussed in Chapter 4. I argued that the different classes of subjective adjectives considered here are able to be categorized by particular *clusters* of syntactic environments, and that certain ones are found more often with one or more classes. The informativity of a given environment is dependent on how restrictive it is. The corpus analysis revealed that certain frames are compatible with a rather wide-range of subjective adjectives; for example, an intensifier (*really, very*) + an adjective is indicative of gradable adjectives more generally. Other environments, however, are more powerful, either because only certain adjectives are found with them, or because they generally "favor" particular classes of subjective adjectives, such that adjectives from these classes are statistically more likely to be found in these syntactic environments. The TALL-class, for example, is uniquely found with measure phrases, and is significantly more likely to be found with *how* and *too* (with or without anything after the adjective, such as an infinitival clause). On the other hand, the TOUGH- and SMART classes of subjective adjectives were often followed by infinitival clauses. I concluded that patterns such as these found in the exposure language provide the foundation for an account of syntactic bootstrapping for these adjectives, given that syntactic information is available that should enable mapping

structure to meaning.

Following up on the findings of the corpus-based analysis, in Chapter 5, I asked if learners are capable of recruiting the information provided by these syntactic environments to determine the meanings of novel adjectives. I presented the results of a word learning experiment with adult participants, based on the Human Simulation Paradigm. The results of this experiment indicated that participants are recruiting the syntactic environment in which a novel word is found to narrow the hypothesis space of possible meanings. This was reflected in several ways. First, the grammatical category of their responses covaried with the frames provided across trials; when presented with frames corresponding to novel nouns and verbs, participants provided guesses belonging to these categories, and when presented with frames for adjectives given the target items, they guessed adjectives. Second, within the target adjective trials, guesses varied based on the syntactic frames, reflecting subcategories of subjective adjectives. Not all syntactic frames were equally helpful to learners, however; participants were significantly more likely to provide compliant responses for the set of prompts for TOUGH, SMART, and TASTY. I argued that this reflected a difference in frame informativity. For example, a frame as in (115a) is consistent with either the TALL or PRETTY-class, but it is also consistent with all five of the subcategories, thus providing less information to the learner, whereas a frame such as (115b) is consistent with only the TOUGH or SMART class.

(115) a. This blicket is so DAXY.

b. It is DAXY to gorp this blicket.

In addition, I reported better performance when participants incrementally guessed and could revise their guesses. Those who received one frame at a time performed significantly better than those who had to wait to guess at the end, after hearing the entire set of adjectival frames. I interpreted this as evidence that being able to revise in real time enables learners to better integrate information from the frames, taking each frame into account as they

narrow down the hypothesis space.

In this rest of this chapter, I will motivate a proposal for adjective learning that is based on the findings of the corpus-based analysis and the word learning experiment. To preview my proposal, I claim that just as with verb learning, information provided by frames helps the learner determine the meaning of subjective adjectives, and that the syntax maps to the semantics. Consistent with the multiple frame hypothesis (Naigles 1996; Mintz 2003), I will argue that adjective learning is probabilistic across a cluster of frames, and that learners update their working hypothesis by calculating the likelihood that an adjective of a given class will appear in each frame. Learning is dependent on the relative informativity of both the individual frames in that cluster and the cluster as a whole. In the next section, I detail a model of language learning that reflects the nature of frame integration as a proof of concept, before discussing considerations for how data should be weighted and how the hypothesis space should be represented. I connect this model to the experimental results in Section 6.2. Then, in Section 6.3, I discuss how this proposal connects and extends to previous acquisition literature. In Section 6.4, I end by discussing remaining questions, and a plan for future research.

6.1 Modeling Adjective Learning and Evaluating Evidence

Most of the studies on verb learning have considered the number of arguments as a source of information (as in e.g. Yuan & Fisher 2009), but further research has also indicated that there are additional syntactic frames and semantic cues that children are sensitive to as well, that allow them to subcategorize types of verbs. For example, as discussed in Chapter 2, children pay attention to specific selectional properties of verbs to distinguish verbs based on the type of complement (Papafragou et al. 2007; Harrigan, Hacquard & Lidz 2016; White et al. 2017), and rely on other co-occurance patterns, such as the animacy of the subject to determine thematic relations (Becker 2006; 2009; 2014). However, subcategorization within a particular category requires that learners pay attention to fine-

grained information, e.g. the tense of the complement clause, to determine word meaning. A single frame is often not enough to subcategorize. Lidz (2020) illustrates this with the following example of change-of-state verbs, which display the alternation below (see also Bunger & Lidz 2004). In order for the child to learn that *break* is a verb that participates in the causative alternation, both frames in (116a) and (116b) need to be observed; (116a) without (116b) simply tells the child that the verb is transitive, and (116b) without (116a) is misleading, if the child is basing the categorization of the verb based on the number of arguments.

(116) a. Kim broke the fence.

b. The fence broke.

The fact that multiple frames are necessary to understand the full range of properties exhibited by the word (such as the verb above) indicates that the learner must be attending to information across multiple syntactic environments (see Fisher, Gleitman & Gleitman 1993; Naigles 1996; Mintz 2003; White et al. 2017). Here I argue that subjective adjectives are an illustrative case study for the need to incorporate information from clusters of frames, rather than from individual frames alone, and that successful learning of these predicates is dependent on integrating frame information to determine its appropriate semantic category.

Previous studies on the effect of multiple frames on learning have focused on cases where there is more of a direct connection between frame and subcategory. For example, while verbs like *believe* are not always found with clausal complements (117a) when they are, these clausal complements are always finite (117b). This type of mapping between embedded clause type and semantic category has been argued to be both reliably coded in the syntax, and a cue that learners are able to exploit (Papafragou et al. 2007; Harrigan, Hacquard & Lidz 2016).[1]

[1] As Harrigan, Hacquard & Lidz 2016 note, exactly how the relationship between syntax and semantics is

(117) a. Olivia believes Elliott.

b. Olivia believes that Elliott will solve the case.

With adjectives, the picture is complicated due not only to the range of frames that each one appears in, but the overlapping nature of these frames, as discussed in Chapter 3. Moreover, certain frames are arguably not as informative in that they only inform the learner that the word could be adjective; the frame in (118a) is compatible with adjectives of all kinds, such as *tall, amusing, fun, delicious, nice, good* (subjective)) or *eager, willing, happy* (non-subjective), but it is also compatible with other categories, such as verbs (e.g. *jumping*) or even proper nouns. The frame in (118b) provides more information, but minimally so. Now the learner is able to establish that this is most likely a gradable adjective, as discussed in Chapter 2 (see also Syrett 2007). At this juncture, the learner still does not know how to subcategorize the adjective. If the learner is provided with a frame as in (118c), she then has information that helps narrow down its possible meanings but, as mentioned, because adjectives often have overlapping frames, this frame does not conclusively identify a particular subclass; it is rather consistent with subjective adjectives such as *tough, smart, pretty* but also potentially non-subjective adjectives like *eager, willing*, if 'blicket' is construed as animate. The last frame in (118d) is the most informative, in that it is the most restrictive– but it is still consistent with at least two adjective classes, the TOUGH-class and the SMART-class.

(118) a. This blicket is DAXY.

b. This blicket is really DAXY.

c. This blicket is DAXY to gorp.

d. It is DAXY to gorp this blicket.

Nevertheless, as the table below indicates, no two classes of adjectives are correlated with

encoded differs cross-linguistically.

the same profile. For example, scalar variation is exhibited by most, but not all, adjective classes. Adjectives differ in terms of whether or not they modify an individual, and thus take an NP subject, an event, or both. Certain characteristics also identify particular subsets of adjectives; only the TOUGH and SMART class selects for expletive subjectives, whereas judge-PPs (*for*-phrases with an experiencer argument) are compatible with three of the five classes. Thus, while these adjectives are alike in certain respects, they are also all uniquely identifiable.

Table 6.1: Adjective Profiles

Adjective	Scalar Variation	Modifies?	Infinitival	MPs	Judge-PP	Expletive
TALL	No	Individuals	No	Yes	No	No
TOUGH	Yes	Events	Required	No	Yes	Yes
TASTY	Yes	Individuals	No	No	Yes	No
PRETTY	Yes	Individuals	Optional	No	Yes	No
SMART	Yes	Both	Optional	No	Yes	Yes

Building on these observations, I argue that not only are multiple frames needed (consistent with Gleitman (1990)) but that certain frames are more informative than others. Based on the findings from Chapter 4, for example, adverbs (*really, very*) are consistent with an interpretation in which an adjective is subjective (and gradable), but will not reveal the specific subcategory that the adjective belongs to. Conversely, expletive subjects should unambiguously indicate that an adjective is in the TOUGH or SMART class. Due the overlapping nature of these frames, I argue that learning subjective adjectives is necessarily probabilistic, with each frame being evaluated as either reinforcing or discouraging a particular categorization. In addition, because not all of these frames are equally informative, I claim that frames are weighted differently, with frames with the least amount of overlap between subcategories being more powerful than ones with more overlap.

6.1.1 Bootstrapping via Probabilistic Deduction

Learning subjective adjectives requires being able to subcategorize appropriately, and I propose that this is accomplished via a process of updating baseline assumptions about

which class an adjective belongs to in real time. Unlike parameter-based models of language learning, where the child is deciding between two possible grammars, a calculation must be made as to which category a given word belongs to given multiple options made available by the grammar. I adopt a model of Bayesian updating, based on Tenenbaum & Griffiths (2001), in which different hypotheses are assigned probabilities that shift depending on the evidence that is considered. Each individual hypothesis (h) is part of a set of hypotheses (H). For simplicity, I start by building a toy model where I assume that each of the five distinct classes of subjective adjectives corresponds to a separate "hypothesis" (in terms of which subcategory a subjective adjective could belong to), and that each of these initially has an equal likelihood (1/5 or 0.2). This assumes that the child is able to initially filter subjective adjectives from non-subjective ones, which I argue is completed via an equivalent process. The data (d) that the child receives will either increase or decrease the likelihood of a given hypothesis. The resulting probability then enables comparison of the hypotheses to determine which is more likely among the set of hypotheses considered. As the learner converges upon the correct hypothesis, the probability of the adjective belonging to the subcategory in question should increase.

I schematize this with a Bayesian theorem, where P corresponds to probability and D corresponds to the data in the input (exact formulation here taken from Pearl 2021). The likelihood of a given hypothesis corresponds to $P(D|h)$, which is the conditional probability of D given the hypothesis (h). This is evaluated with respect to the prior $P(h)$, which is the probability value assigned to a particular hypothesis before any data is taken into consideration. The likelihood is multiplied by the prior corresponds to the numerator ($P(D|h)*P(h)$). The full model involves determining the posterior probability, which is calculated by dividing the numerator by the probability of D with respect to any hypothesis ($P(D)$), which is referred to as the normalizing factor. I assume a model that is updated as data is incrementally encountered and processed. I focus on the numerator for hypothesis comparison, and calculate the probability that a given adjective class is the correct one for each frame

by taking the likelihood*the prior (as is standard for hypothesis comparison, see e.g. Pearl 2021; Tenebaum & Griffiths 2001; Reiger & Gahl 2004; among others).

(119)

$$P(h|D) = \frac{P(D|h)*P(h)}{P(D)} = \frac{P(D|h)*P(h)}{\sum_{h' \in H} P(D|h')*P(h')} \propto P(D|h) * P(h)$$

The likelihood of a given hypothesis depends on a variety of factors, but a common approach is to assign data conforming to the hypothesis a probability of 1 and data not conforming to the hypothesis a probability of 0. Here I propose a slightly different schema for likelihood in order to reflect that some frames are more informative than others. For example, a frame that is consistent with all subjective adjective classes does not contradict any prior hypothesis, but it also does not confirm membership in any particular category. In order to build this toy Bayesian model, I assume that the amount of overlap determines the relative probability for reinforcing the likelihood that the adjective belongs to a particular category. All frames that correspond to any of the five adjective classes is also assigned a likelihood of 0.2. If a particular frame is only consistent with one of the adjective classes, then this uniquely identifies that class and the probability is 1. In other words, the more unique the frame, the greater the likelihood that it identifies a particular class and the more influence it has on the learner.

To calculate the probability in situations in which a frame is neither consistent with all or just one class, I argue that probability is divided according to the number of adjective classes consistent with the frame of interest. For example, expletive subjects are consistent with only the TOUGH and SMART classes, which means that the probability that a given adjective with an expletive subject belongs to either class is 0.5. To give a concrete example, suppose that the learner has to determine what DAXY means. As mentioned, it is initially assumed it is equally likely that this adjective belongs to any of the subjective adjective classes, so the learner will assign the prior a probability of 0.2. Now suppose the learner

encounters the expletive subject frame with a likelihood of corresponding to the TOUGH-class at 0.5. The likelihood*prior (*lp*) yields 0.1. On the other hand, the likelihood of the adjective belonging to the TALL-class is near 0. Hypotheses are often assigned a non-zero estimate, regardless of how unlikely (see Pearl 2021), thus I assign the likelihood that the expletive corresponds to the TALL-class an extremely low probability of 0.01 for ease of demonstration. This results in a probability of 0.002. Hypotheses comparison (i.e. determining the posterior odds ratio) is accomplished by dividing lp_{tough} by lp_{tall} ($\frac{0.01}{0.002}$ = 5), which in turn informs us that the adjective is 5 times more likely to belong to the TOUGH-class than the TALL-class, as illustrated by (120). Here I compare only two of the adjective classes, but the same calculations result in equivalent findings when TOUGH/SMART is compared to any of the other two adjective classes considered here based on the expletive frame. As mentioned, I assume a prior of 0.2, which means that all five subclasses are considered equally likely before a frame is encountered.

(120) It is DAXY to play this game. $lp_{tough}(0.5)(0.2) = 0.1$

$lp_{tall}(0.01)(0.2) = 0.002$

The aforementioned example considers the influence of one frame alone. However, these adjectives appear in a variety of frames, and learners will need to track adjectives across them. Each time a learner encounters a new frame, the probability assigned to a given hypothesis changes. Here I take the sum of probabilities to determine the likelihood of the cluster of two frames, $(P(A) + P(B) - P(A \cap B))$. As the learner accumulates more information, the likelihood that the cluster of frames belongs to a given class fluctuates according to the frames that are added.

(121) a. This game is DAXY to play. lp_{tough} = (0.33)(0.2) = 0.06

b. It is DAXY to play this game. lp_{tough} = (0.67)(0.2) = 0.13

c. Playing this game is DAXY. lp_{tough} = (0.84)(0.2) = 0.17

6.1.2 Reevaluating Conditional Likelihoods: Considering Frequency

The model proposed here is an idealized model where all adjective classes are considered equally likely. It could be argued that the proportion of occurrences in the input needs to be factored in, such that different adjective classes are associated with different priors. Given that the TALL-class is more frequently found in the input (as Chapter 4 illustrates), we might assume that this class is (somewhat) favored in terms of having a larger prior. This model is also based on how the probability of a particular hypothesis shifts based on a single frame, not taking into account the the role of the number of occurrences for each of the individual frames. Chapter 4 considered the distribution of frames observed with subjective adjectives. Based on the findings, we observe that while a certain frame may be compatible with an adjective in theory, this is not always reflected by the input data. In the previous example, I assigned the likelihood of an infinitival given the hypothesis that the adjective belong to the TOUGH-class a value of 0.33. However, in the corpora consulted, an infinitival clause was found after a TOUGH-adjective 234 times out of 392 times total (of all subjective adjectives with an infinitival clause)– thus accounting for 60% of this particular frame when surfacing with adjectives. The likelihood that this frame is found with a TOUGH-class adjective could thus be closer to 0.60, if the clustering of frames is taken into account.[2] Following this reasoning, none of the classes would be assigned a non-zero likelihood, just as before, but the exact value is a bit higher if the distribution is taken into consideration.

In this case, if the learner encounters the frame below, now the probability that DAXY belongs to the TOUGH-class is higher, and the probability that it belongs to the SMART or PRETTY-class quite low, which is a departure from the previous model in which infinitival clauses were considered equally strong support for either of these three classes. The benefit of adjusting likelihood based on the distribution of frames in the input is that it is better

[2]This is again assuming that the non-subjective adjectives have been filtered out at this point in the learning process. It is possible to build the model with a sixth "hypothesis" for non-subjective adjectives, but this will consequently dilute the prior and the likelihood for any of the hypotheses.

Table 6.2: Distribution of Frames with Infinitival Clauses (CHILDES results)

Adjective	Raw Counts	Percentage
TOUGH	234	0.60
SMART	44	0.11
TASTY	9	0.02
PRETTY	7	0.02
TALL	98	0.25
Total	392	

representative of the information the child is receiving from the input, while also capturing some of the noise that exists in the input as well. Subjective adjectives are a good illustration that language learning that cannot be categorized by simple binary choices, such as "fits frame" or "does not fit frame," as exemplified in this example.

(122) This game is DAXY to play.

$$lp_{tough} = (0.60)(0.2) = 0.12$$

$$lp_{smart} = (0.11)(0.2) = 0.02$$

$$lp_{pretty} = (0.02)(0.2) = 0.004$$

In sum, learning adjectives requires calculating the probability that it belongs to a particular class, and narrowing down the hypothesis space translates to increasing the probability that the adjective has been sorted correctly. Since adjectives are associated with a wide range of frames, this necessitates observing the adjectives in a variety of syntactic environments.

6.1.3 Reevaluating Priors: Considering the Hypothesis Space

This toy Bayesian model assumes that children know that there are five subcategories of subjective adjectives. Syntactic bootstrapping is argued to be a viable learning strategy because it claims that children have grammatical knowledge provided by UG in order to guide them; it is for this reason that mapping between structure and meaning is possible. For instance, a specific claim in the bootstrapping literature is that children rely on participant-to-argument mapping (PAM), which assumes that children know that there are

arguments with thematic roles, that verbs may or may not select for an argument (and thus that there are different kinds of verbs, with different selectional requirements), and that agents and patients are canonically mapped to particular syntactic positions. Children use this knowledge about structure to figure out the meanings of novel verbs. In other words, children are equipped with scaffolding from UG that supports them in the learning process. Just as children have expectations about syntactic structure that helps them learn verbs, we can assume that children have expectations about adjectives. Children have a knowledge about scalar structure, which enables them to distinguish gradable from non-gradable adjectives, and relative gradable adjectives from absolute gradable adjectives (Syrett 2007; Syrett & Lidz 2010; Syrett et al. 2010). If scalar structure is part of UG, such that children know that this is an option available in the Grammar, then this would provide them with the scaffolding to make certain distinctions. We would thus want to take this into consideration when building any learning model; if adjective classes belong to (hypothesis) bins, then Gradable and Non-Gradable are two such bins. UG also refers to knowledge of syntactic operations, such as movement. Children again demonstrate early knowledge or particular operations such as movement. If children are able to use e.g. animacy as a cue to movement, it seems reasonable to assume that children know that animacy is revealing as to the thematic relation between the subject and the predicate, and can use that to deduce that a predicate has been displaced (Becker 2014). This would also suggest that the option for Displaced/Raising Predicates (TOUGH-class adjectives) and Non-Displaced/Control Predicates (SMART-class) should also be built into the model. The extent to which learners are aware of subjectivity remains an open question, but if it is believed that distinctions that languages make correspond to options available in UG, then learners would have to determine if an adjective is associated with a judge or not– using information from the input– but they would not need to "acquire" a judge parameter. In other words, the priors here are rooted in UG, and correspond to conceptual and grammatical information (e.g. scalar structure, the availability of a judge, individuals vs. events) that forms the scaffolding for

the language acquisition process. Learners are tracking frames that reveal this underlying structure and would signal the appropriate categorization; that is, if the learner knows that gradable adjectives select standard-phrases, then encountering a *than*-clause in the input would be informative.

However, both the unadjusted and adjusted models proposed assign equal weight to the priors. It could be the case that these priors should be weighted differently for several different reasons: (1) priors may be weighted according to how typologically common or uncommon a particular adjective type is across languages, or based on the relative size of a particular class in any given language. (2) Particular hypothesis may correspond to default expectations, or certain baseline assumptions in the grammar. In regard to the first point, the five subjective adjective categories in English are not intended to be representative of how the same adjectives are categorized in all languages. Certain languages have different categorical distinctions– not all languages may have e.g. a SMART-class. This model would need to assume that in this case that although the SMART-class is a hypothesis within the set of hypotheses offered by UG that there would be nothing in the input that would reward such a categorization. Additionally, categorizations that are more rare may be correlated with a prior with a lower probability, such that essentially there would be a greater burden of proof imposed on the learner to motivate a particular category. Note that this is not claiming that children are learning from negative evidence, but that the data in the input will converge with other hypotheses. Under this model, adjusted for typological considerations, the learner should converge on more cross-linguistically attested patterns faster. In regard to the second point, in terms of baseline assumptions, this too would skew prior probabilities; while some classes may still be considered equally likely, others like the TOUGH-class may be assigned a lower probability.

Lastly, this model is two-tiered, in that it assumes that children first evaluate adjectives and classify them as subjective or non-subjective, and then later evaluate subjective adjectives to sort them into subcategories. This design thus builds in ordering information;

while this allows us to focus on what kinds of information learners are assessing within the space of subjective adjectives, children are arguably considering whatever data is available, as opposed to sorting data in a stepwise fashion. Depending on how we want to divide the "non-subjective" space (which was treated as a monolithic bin for the purposes of this research), this could amount to extending the hypothesis space from five competing hypotheses to six or more. The original model presented here is a proof of concept– it is quite possible (and rather likely) that the priors associated with these categories are too idealized. As we learn more about the factors that should go into the model, this will enable more precise modeling that more closely reflects the learning process.

6.1.4 Tracking Information

One final consideration involves how adept learners are at tracking information. The proposal thus far has been that learners incrementally integrate information from frames; as they encounter information, they adjust their hypothesis space, eventually leading to the correct interpretation of a word. This would predict that so long as the frames are encountered and available, learners should be able to succeed. In the word learning experiment in Chapter 5, we observed a benefit from being able to guess the meaning of adjectives incrementally as opposed to waiting until the end of the trial. The model alone does not factor in any advantage or disadvantage for how data (frames, in this case) is presented to the learner. However, in order for syntactic bootstrapping to work across multiple frames, the learner must necessarily keep track of the information from all frames, holding these frames in memory. Exactly how this information is stored and processed is an open question, and I argue that the results from the word learning experiment may weigh in on this issue. Participants who guessed at the end of each trial had to retain all four frames in memory as they generated their guess. Those in the incremental conditions, however, could revise their previous response after each frame, checking to see if their previous guess is congruent with the new frame. Additional research is needed to assess the contribution of working

memory to the model proposed here.

6.2 Word Learning is Easy– Depending on the Frames

Regardless of the weights that are ultimately assigned to each of the frames, the model that I have proposed crucially assumes that certain frames are more informative and therefore help learners converge on the target adjective faster. This proposal is supported by the results from the word learning experiment reported in Chapter 5. Participants provided the highest rates of frame-compliant responses for TOUGH, SMART and TASTY. The prompts for TOUGH and SMART had expletive subjects and infinitival clauses, which (as discussed above) are given more weight, as they will more strongly reward or punish a particular hypothesis, and participants performed well in both conditions. The unadjusted model has the likelihood of these frames as supporting TOUGH or SMART at 0.5 and 0.33, respectively, and the likelihood of supporting any other class at 0. The adjusted model had the likelihood of infinitival clauses supporting the TOUGH-class at 0.59– which means that participants should be more likely to guess an adjective from the TOUGH-class. This is what is reflected in their responses; guesses for both the TOUGH and SMART-class prompts often corresponded to the former class, further complimenting the corpus results.

Table 6.3: Frequent Responses (Collapsing across Conditions)

Frame Set	Response	Adjective Class
TOUGH	Fun	TOUGH
	Good	TOUGH
	Easy	TOUGH
SMART	Good	TOUGH
	Fun	TOUGH
	Healthy	TOUGH
TASTY	Cool	TOUGH
	Tasty	TASTY
	Pretty	PRETTY

Participants also performed well with the TASTY-class prompts. Recall, however, that frame-compliance was determined not based on if the participant guessed an adjective in

the intended class, but rather on if they provided an adjective that is consistent with the set of frames. Based on the (unadjusted) likelihoods assigned to these individual frames (123), these frames are consistent with the TASTY-class, but also consistent with other classes too. This is again reflected in the guesses provided. This raises the question of how the TASTY-class is learned, keeping in mind that negative evidence is not available to inform the learner that this class is not compatible with certain elements, such as measure phrases or expletive subjects. The answer might be tied to the semantics of the modified noun; for example, examples like *delicious* or *disgusting* describe properties of objects that can be "experienced" in some way, and include several adjectives that reference one of the senses (e.g. *tasty, smelly, spicy/salty/sour/sweet/tart, soft, cozy, funny-looking*). These adjectives may thus co-occur with a particular set of nouns that share certain semantic characteristics, and it is thus these co-occurence patterns that learners rely on in addition to the syntax to subcategorize. This is in line with earlier proposals that the lexical semantics of co-occuring words influence learners and help them deduce the meanings of novel words (Levin-Rappaport-Horav 1991; Pinker 1994; see also Altmann & Kamide 1999 for similar claims with respect to processing).

(123) a. He says heaches are not daxy,
but I think heaches are really daxy. likelihood of frame = 0.20

b. I think this heach is so daxy. likelihood of frame = 0.20

c. To me, this is such a daxy heach. likelihood of frame = 0.25

d. I find this heach to be very daxy. likelihood of frame = 0.25

In other words, the results from the word learning experiment illustrate that participants are paying attention to the frames in which an adjective is found to narrow down potential meanings. Additional semantic information available within frames enables participants to eliminate particular hypotheses that are consistent with the syntax but not the semantics. In this experiment, most semantic information was purposefully stripped away so

that participants only had the syntax to rely on; the only semantic cue came from adverbs that signaled gradability, but not particular category membership. However, if participants were told that *heaches* are *cookies* or another food, this would arguably have influenced the types of responses elicited. While syntax is informative, it is not enough for learning certain predicates.

6.3 Implications for (Delayed) Acquisition

As mentioned, the unadjusted model assumes that all subjective adjective classes are considered equally probable by the learner. Beyond considerations of input frequency, there is another reason to think that this might not be the case: children have well-documented difficulties with certain types of adjectives, notably *tough*-adjectives (see Chomsky 1969; Cromer 1970; Cambon & Sinclair 1974; Solan 1978; Macaruso et al. 1993). Children assign what appears to be a control interpretation to these adjectives. A well-known example comes from Carol Chomsky (1969). In an experimental task, Chomsky presented children with a blindfolded doll and asked the children if the doll is easy to see; children who responded that the doll is hard to see were instructed to make the doll "easy to see" – which prompted them to remove the blindfold. Chomsky argued that this illustrated that children initially interpret (124a) as (124b).

(124) a. The doll is easy to see.

b. The doll sees easily.

The general assumption in the literature has been that these difficulties reflect a non-adult-like syntactic representation in some form, which in turn is responsible for non-adult-like interpretations of these adjectives. These are adjectives that have non-canonical syntax, which means that the argument in subject-position is interpreted as the object; under most analyses, the object undergoes A-movement to subject position, moving into subject-position. For this reason, *tough*-adjectives are known as raising predicates (or displaced

predicates, Becker 2014). These adjectives contrast with control adjectives (125b), which have canonical alignment, as the subject is interpreted as the agent. These are thus non-displacing predicates, given that the subject has not moved from its baseline position.

(125) a. The doll is easy (for us) to see <the doll>.

b. Mary is eager to see the doll.

It has been suggested that children either have difficulties with A-movement more generally (Borer & Wexler 1987; Wexler 2004), or with movement across an intervening argument, which in this case corresponds to the *for*-phrase (Hyams & Snyder 2005; Orfitelli 2012; Mateu 2020). In other words, the claim is that children assign a control analysis because they have a deficient syntactic mechanism (regardless of the exact source of the difficulty). Becker (2006; 2009; 2014; 2015) takes a different approach, focused on learnability. Becker (2014) argues since syntactic bootstrapping is predicated on the assumption that there is canonical alignment, in which children can reliably map arguments to certain thematic positions (agents as subjects and patients as objects), the frames that these adjectives are found in can be deceptive. The strings as in (126) are more or less equivalent, so any child relying on these frames will not know that these have different syntactic representations.

(126) a. Kate is easy to impress. raising

b. Kate is eager to impress (Rick). control

The consequence is that adjectives of different classes appear to be found in the same frame. Becker claims that other types of information within the frame are able to guide the learner, specifically the animacy of subject. Inanimate subjects are found with tough-adjectives alone, and children are able to exploit this to learn which predicates are raising predicates (Becker 2015). Nevertheless, while animacy as a semantic cue is able to guide

children during the acquisition process as far as learnability is concerned, there still remains the issue of *why* children assume the non-adult-like interpretation to begin with, especially considering that Becker (2015) has shown that children from the youngest ages tested (3 years) display adult-like behavior if variables like subject type are controlled for. Here I attempt to push these findings further, by suggesting that another interpretation of early non-adult-like responses in acquisition studies is tied not to deficient syntax but to miscategorization.

Focusing on the frames, we have already seen that there is overlap between where we find tough-adjectives (those in the TOUGH-class) and other subjective adjectives, and finer-grained distinctions are revealed when various classes of subjective adjectives are considered. In line with this observation, regardless of how helpful of a guide a semantic cue like animacy is, it must be working in tandem with other sources of information, given that most of the adjective classes considered here are compatible with inanimate subjects.

(127) a. This book is tough to read.
b. This cheesesteak is delicious.
c. This dress is pretty (to wear).
d. This race is long.

The child thus cannot rely on animacy information alone, but rather must rely on other information in the syntactic frame in order to inform them that some adjectives are associated with non-canonical-alignment. If children need to learn that this is a possibility, then this immediately implies that the baseline assumption is that the adjective is not a member of the TOUGH-class. From the corpus search, it is also evident that non-displacing adjectives are more likely to be found in the input. Thus, in addition to adjusting the likelihood that a given adjective supports a particular hypothesis, children may be assigning different priors. In other words, I am arguing that there is a greater burden of proof for children to abandon an analysis in which the adjective has a thematic relationship with the argument

in subject position. Under my analysis, children are not interpreting e.g. *easy* as a control adjective because they lack raising-to-subject in their grammars, but because they have not sorted it into the proper category. The reason that children are able to perform well when experimental prompts are carefully designed connects to the strength of the cluster of frames. Taking (128) as a representative target prompt from Becker (2015), note that this frame has both an expletive subject and an infinitival clause, both which I have argued are associated with a high probability that an adjective belongs to the TOUGH-class. Thus, when considering the syntactic frame and the semantic cue provided by (in)animacy, children have enough information for them to reward the target grammar. In the absence of such information, the child may default to another categorization. Being being too quick to re-categorize (given less evidence, for example) would lead to other types of errors; for example, sorting an adjective into the TOUGH-class anytime there is an inanimate subject would lead to grouping adjectives such as *tall* and *tasty* together with *tough*, when we know that all three adjectives have distinct syntactic profiles.

(128) Is it stroppy to hide a motorcycle in the box? (Becker 2015, pg. 97)

6.4 Conclusions

In this dissertation, I sought to address the applicability of syntactic bootstrapping in the adjectival domain though the lens of subjective adjectives. Syntactic bootstrapping was originally proposed due to the limitations of deducing word meanings via observation; even in the most ideal learning conditions, in which a word corresponds to an observable object, event, or property, the learner still has to filter out the intended meaning from the entirety of the visual scene. This task quickly becomes more difficult as the learner needs to acquire words without a visual correlate (e.g. verbs like *think* or *seem*). Subjective adjectives (*easy, fun*) do not correspond to fixed, observable properties, and they also introduce an

additional layer of complication, given that these adjectives are anchored to a judge – that is, the applicability of the adjective depends on the perspective of either the speaker or another individual made salient in the discourse. I argued that learners are able to recruit syntactic information to acquire these adjectives, just as with verbs.

I have focused on five subcategories of subjective adjectives, arguing that the syntactic profiles associated with these adjectives correspond to clusters of frames that enables learners to categorize novel adjectives. As with any learning puzzle, the first concern is if there is enough information in the input that would support successful acquisition. Unlike certain predicates that require an argument or clause, subjective adjectives do not obligatorily select for particular complements, standards, or modifiers. Given the range of syntactic environments in which these adjectives are compatible with, this also implies that learners will encounter the same adjective in a variety different of different environments. With these considerations in mind, an analysis of the input nevertheless reveals that different types of subjective adjectives cluster in particular ways, such that certain subclasses are more likely to be found in conjunction with specific syntactic elements. Following others (Naigles 1996; Mintz 2003; Bunger & Lidz 2004; see also Lidz 2020 for discussion), I argue that learning is facilitated by exposure to a cluster of frames, which in tandem help the learner arrive at the correct interpretation and categorization of a given adjective. Not only is this information available in the input, learners are able to extract information from frames when determining the meaning of novel adjectives, as demonstrated in the word learning experiment presented here.

Building on the results from both the corpus-based analysis and the word learning experiment, I have proposed that learning subjective adjectives is best captured with a Bayesian model in which learners evaluate frames based on the likelihood that the frame is consistent or inconsistent with a particular adjective class. As learners receive more information– in this case, another frame– they shift their hypothesis space accordingly. Eventually, the learner is able to arrive at the correct categorization if and only if the entire

cluster uniquely supports this analysis over all others. Given this process of evaluating and weighing hypotheses in real time, I have lastly suggested that previous studies reporting developmental delays with certain adjective types may potentially be reframed with this model in mind, such errors are not necessarily a result of deficient syntax, but rather a reflex of the learner holding onto baseline assumptions for categorizing predicates. Future research should work to further illuminate other frames and sources of information that work together to support learning, as well as reveal cross-linguistically relevant differences in the range of syntactic environments that learners rely on when acquiring adjective meanings to better represent the word learning process.

Appendices

APPENDIX A

WORD LEARNING: EXPERIMENTAL ITEMS AND SCRIPT

Practice

verb with transitive frame + sentential complement [cheem]

*possible guesses: ?think, *say, know, *believe*

A: What's going on?

B: The girl cheems that the tanzer smopped.

A: Oh really? The girl cheems that the tanzer smopped?

PAUSE

B: Right, the tanzer smopped, and somehow the girl cheems that the tanzer smopped.

A: I see. The tanzer smopped, and somehow the girl cheems that the tanzer smopped.

PAUSE

B: Yeah, the tanzer smopped, and the girl cheems about it.

A: Mm hmm, the tanzer smopped, and the girl cheems about it.

PAUSE

B: I thought it was a secret. I don't know how she cheems that.

A: Yeah, I don't know how she cheems that.

Control Trials

(1) **verb with transitive frame + sentential complement [pilk]**

*possible guesses: *think, say, *know, *believe*

A: What's going on?

B: The girl pilks that the lorp is gonna ziff.

A: Oh really? The girl pilks that the lorp is gonna ziff?

PAUSE

B: Yeah, she pilked that to me yesterday.

A: Oh, she pilked that to you yesterday?

PAUSE

B: Yeah, the lorp is not gonna ziff, but the girl pilked that the lorp is gonna ziff.

A: I see. The lorp is not gonna ziff, but the girl pilked that the lorp is gonna ziff.

PAUSE

B: You know, I don't know why she pilked that.

A: Yeah, I don't know why she pilked that.

(2) **verb with transitive frame [roak]**

A: What's happening?

B: The boy is going to roak the tami.

A: Wow, the boy is going to roak the tami?

PAUSE

B: Yeah, the tami will be roaked by the boy.

A: Oh got it, the tami will be roaked by the boy.

PAUSE

B: In fact, the boy is going to roak the tami with the husp.

A: Oh, the boy is going to roak the tami with the husp?

PAUSE

B: Mm hmm, the boy is going to roak the tami with the husp slowly.

A: I see. The boy is going to roak the tami with the husp slowly.

(3) **count noun [modi]**

A: What do you have in that bag?

B: These are modis.

A: Oh? Those are modis?

PAUSE

B: Yeah, in fact, I have 1, 2, 3 modis.

A: Wow, you have 3 modis?

PAUSE

B: Mm hmm, and there are more modis over there!

A: Oh wow, there are more modis over there!

PAUSE

B: That's right. I could have so many modis!

A: Yeah! You could have so many modis.

(4) **mass noun [foom]**

A: What is that in the bowl?

B: This is some foom.

A: Oh? That is some foom?

PAUSE

B: Yeah, in fact I have a lot of foom.

A: Wow, you do have a lot of foom!

PAUSE

B: In fact, there is too much foom!

A: You're right. There is too much foom.

PAUSE

B: I think there is less foom over there.

A: I agree. There is less foom over there.

Target Trials— Single Adjective Conditions

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(1) Adjective Class: Good [daxy]

*Possible guesses: *tasty, ?tough, good, *pretty, *tall*

A: What is that on the tray?

B: That is my blicket.

A: Oh, that's your blicket?

B: Yeah, my sister gave this blicket to me.

PAUSE

B: She says it is daxy to gorp this blicket.

A: Oh, she says it is daxy to gorp this blicket?

PAUSE

B: Yes, and I agree. It is daxy for us to gorp blickets.

A: Yeah! It is daxy for us to gorp blickets.

PAUSE

B: Indeed. It is very daxy for us.

A: You're right. It is very daxy for us.

PAUSE

B: Yeah, gorping blickets is very daxy to do.

A: I agree. Gorping blickets is very daxy to do.

(2) Adjective Type: Tough [daxy]

*Possible guesses: *tasty, tough, ?good, *pretty, *tall*

A: What is that on the shelf?

B: That is a bosa.

A: Oh, that is a bosa?

B: Yeah, I got this bosa from school.

PAUSE

B: You know, it is daxy to fott this bosa!

A: Oh wow, it is daxy to fott this bosa!

PAUSE

B: Yeah, fotting this bosa is so daxy!

A: Mm hmm, fotting this bosa is so daxy!

PAUSE

B: And bosas are daxy for us to fott.

A: Oh, yes! Bosas are daxy for us to fott.

PAUSE

B: Indeed, fotting bosas is daxy for us.

A: I hear you. Fotting bosas is daxy for us.

(3) Adjective Type: Tasty [daxy]

*Possible guesses: tasty, *tough, pretty, good, *tall*

(note: pronoun change is intentional)

A: What is that on the table?

B: That is a heach.

A: Oh, that is a heach?

B: Yeah, my friend made this heach for me.

PAUSE

B: He says heaches are not daxy,

but I think heaches are really daxy!

A: Oh? He says heaches are not daxy,

but you think heaches are really daxy?

PAUSE

B: Yes, and I think this heach is so daxy.

A: I see, you think this heach is so daxy.

PAUSE

B: Right, to me, this is such a daxy heach.

A: I understand, to you, this is such a daxy heach!

PAUSE

B: Yes, I find this heach to be very daxy.

A: Got it! You find this heach to be very daxy!

(4) Adjective Type: Pretty [daxy]

*Possible guesses: *tasty, *tough, pretty, good, *tall*

A: What is that next to you?

B: That is a tulver.

A: Oh, that is a tulver?

B: Yeah, my friend gave me this tulver.

PAUSE

B: She thinks tulvers are not daxy, but I think tulvers are really daxy!

A: Oh? She thinks tulvers are not daxy, but you think tulvers are really daxy?

PAUSE

B: Yeah, in fact, this tulver is daxy enough to zeb!

A: You're right. This tulver is daxy enough to zeb!

PAUSE

B: Actually, I consider this tulver to be very daxy!

A: Ah, you consider this tulver to be very daxy!

PAUSE

B: It is surprising to find a tulver like this. What a daxy tulver!

A: Yeah, it is surprising to find a tulver like this. What a daxy tulver!

(5) Adjective Type: Tall [daxy]

*Possible guesses: *tasty, *tough, *pretty, *good, tall*

A: What is that near you?

B: That is a greeb.

A: Oh, that is a greeb?

B: Yeah, I found this greeb.

PAUSE

B: This greeb is very daxy for a greeb!

A: Yes! This greeb is very daxy for a greeb!

PAUSE

B: I've seen greebs before. This is such a daxy greeb!

A: I agree. This is such a daxy greeb.

PAUSE

B: You know what, this greeb is 2 chopanis daxy!

A: Right! This greeb is 2 chopanis daxy!

PAUSE

B: Actually, this greeb may be too daxy.

A: I agree. This greeb may be too daxy.

Target Trials—All Adjective Conditions

(1) Adjective type: Good [daxy]

*Possible guesses: *tasty, ?tough, good, *pretty, *tall*

A: What is that on the tray?

B: That is my blicket.

A: Oh, that's your blicket?

B: Yeah, my sister gave this blicket to me.

PAUSE

B: She says it is daxy to gorp this blicket.

A: Oh, she says it is daxy to gorp this blicket?

PAUSE

B: Yes, and I agree. It is daxy for us to gorp blickets.

A: Yeah! It is daxy for us to gorp blickets.

PAUSE

B: Indeed. It is very daxy for us.

A: You're right. It is very daxy for us.

PAUSE

B: Yeah, gorping blickets is very daxy to do.

A: I agree. Gorping blickets is very daxy to do.

(2) Adjective Type: Tough [wilpy]

*Possible guesses: *tasty, tough, good, *pretty, *tall*

A: What is that on the shelf?

B: That is a bosa.

A: Oh, that is a bosa?

B: Yeah, I got this bosa from school.

PAUSE

B: You know, it is wilpy to fott this bosa!

A: Oh wow, it is wilpy to fott this bosa!

PAUSE

B: Yeah, fotting this bosa is so wilpy!

A: Mm hmm, fotting this bosa is so wilpy!

PAUSE

B: And bosas are wilpy for us to fott.

A: Oh, yes! Bosas are wilpy for us to fott.

PAUSE

B: Indeed, fotting bosas is wilpy for us.

A: I hear you. Fotting bosas is wilpy for us.

(3) Adjective Type: Tasty [brispy]

*Possible guesses: tasty, *tough, pretty, good, *tall*

(note: pronoun change is intentional)

A: What is that on the table?

B: That is a heach.

A: Oh, that is a heach?

B: Yeah, my friend made this heach for me.

PAUSE

B: He says heaches are not brispy, but I think heaches are really brispy!

A: Oh? He says heaches are not brispy, but you think heaches are really brispy?

PAUSE

B: Yes, and I think this heach is so brispy.

A: I see, you think this heach is so brispy.

PAUSE

B: Right, to me, this is such a brispy heach.

A: I understand! To you, this is such a brispy heach!

PAUSE

B: Yes, I find this heach to be very brispy.

A: Got it! You find this heach to be very brispy!

(4) Adjective type: Pretty [spoovy]

*Possible guesses: *tasty, *tough, pretty, good, *tall*

A: What is that next to you?

B: That is a tulver.

A: Oh, that's a tulver?

B: Yeah, my friend gave me this tulver.

PAUSE

B: She thinks tulvers are not spoovy,

but I think tulvers are really spoovy!

A: Oh? She thinks tulvers are not spoovy,

but you think tulvers are really spoovy?

PAUSE

B: Yeah, in fact, this tulver is spoovy enough to zeb!

A: You're right. This tulver is spoovy enough to zeb!

PAUSE

B: Actually, I consider this tulver to be very spoovy!

A: Ah, you consider this tulver to be very spoovy!

PAUSE

B: It is surprising to find a tulver like this. What a spoovy tulver!

A: Yeah, it is surprising to find a tulver like this. What a spoovy tulver!

(5) Adjective type: Tall [gloopy]

*Possible guesses: *tasty, *tough, *pretty, *good, tall*

A: What is that near you?

B: That is a greeb.

A: Oh, that is a greeb?

B: Yeah, I found this greeb.

PAUSE

B: This greeb is very gloopy for a greeb!

A: Yes! This greeb is very gloopy for a greeb!

PAUSE

B: I've seen greebs before. This is such a gloopy greeb!

A: I agree. This is such a gloopy greeb.

PAUSE

B: You know what, this greeb is 2 chopanis gloopy!

A: Right! This greeb is 2 chopanis gloopy!

PAUSE

B: Actually, this greeb may be too gloopy.

A: I agree. This greeb may be too gloopy.

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