Learning from Positive Evidence: The Case of Verb Argument Structure and the Problem of Overgeneralization

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Dissertation Proposal

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1. Introduction

How do children acquire the structural properties of verbs? This question has long received much attention in the field of child language acquisition (Goldberg, Casenhiser, and Sethuraman 2004; Gropen, Pinker, Hollander, and Goldberg 1991; Pinker 1989; Theakston, Lieven, Pine, and Rowland 2001, 2004; Wonnacott, Newport, and Tanenhaus 2008; i.a.), and remains relevant to this day. While many verbs can occur in multiple syntactic frames, a good portion of verbs are restricted in terms of their argument structure. For instance, some verbs can only occur as transitives (1)-(2), while others can only occur in an intransitive frame (3)-(4).

(1) **hit**
   a. John hit Bill.
   b. *John hit.

(2) **touch**
   a. John touched Bill.
   b. *John touched.

(3) **vanish**
   a. Bill vanished.
   b. *John vanished Bill.

(4) **fall**
   a. Bill fell.
   b. *John fell Bill.

At times, the syntactic properties of verbs vary, even within the same semantic class. Furthermore, the learner cannot readily determine whether they haven’t heard a particular verb form because it is ungrammatical, or because the opportunity to use the form simply never presented itself.

In addition to variation among the syntactic frames a verb can occur in, the acquisition of verb argument structure is further complicated by the fact that children are productive users of language. They do not simply stick to what they hear in the input, as is evident from the errors we encounter in child data. Children form rules in their language, and we must address the question of when and how these rules are generalizable to forms the learner has not encountered in the input. We cannot, crucially, adopt a strict lexicalist approach (e.g. Baker 1979; Fodor 1985) to the problem, as novel verbs entering the grammar adhere to a previously established pattern.

The proposed dissertation concerns itself with three cases where the learner must make decisions regarding the verb argument structure: the acquisition of raising and control constructions, the acquisition of causatives, and the acquisition of passives. Raising and control constructions are relevant to theories of verb argument structure acquisition, as raising verbs do not introduce an external argument. In this case, the child must conclude that even through raising verbs do not introduce an external argument, control verbs do. Second, for the acquisition of causatives, we have already seen that not all intransitive verbs can occur in transitive causative frames (3)–(4). The child must learn that some intransitive verbs do not causativize, while still maintaining that the causative alternation rule is productive in the adult grammar, since adult speakers of English willingly causativize novel intransitive verbs. The third case, the acquisition of passives, is similarly relevant. Verbs in passive constructions do not project an external argument, and the thematic object raises to become the surface subject. This raises interesting questions for the acquisition of syntactic structure. For each of these cases, I discuss how children come to acquire the verb argument structure, and learn the patterns that one finds in the adult grammar.
In the proposed dissertation, I also examine the problem of overgeneralization in the aforementioned cases. The problem of overgeneralization refers to instances where the learner has generalized to a superset grammar, and cannot retreat to the subset grammar in the absence of negative evidence. This learnability problem is often referred to in the literature as Baker’s paradox (Baker 1979). I address this problem by showing that the generalizability of any rule can be determined from the data in the input. When there is sufficient motivation for the rule, the learner generalizes, and they retreat from their generalizations when the statistical properties of the input change such that there is no longer sufficient motivation. Adopting Yang’s (2005, 2016) Sufficiency Principle, I show when it is possible for the learner to generalize from the input. In the acquisition of control and raising predicates, I argue that the problem of overgeneralization does not arise, even though it has been proposed otherwise in the literature. I present an analysis of the acquisition of control and raising predicates that illustrates the conditions under which one would expect the learner to overgeneralize, and I show that these conditions do not hold. I then take a look at the acquisition of causatives, which is a true case of overgeneralization. Finally, I examine the acquisition of passives, and determine when the construction is acquired by the learner given the data in the input.

Throughout the proposed dissertation, I will also focus on the role of the input, and how input is used in the acquisition process. In examining children’s competencies of certain constructions, the data that are available to them in the input are of utmost importance. The mastery of certain constructions may depend on the evidence available in the primary linguistic data, and therefore, my claims addressing the acquisition of verb argument structure clarify whether learning is driven by the data in the input, or whether it is innately available to the learner.

This proposal is structured as follows: first, I present a brief background on the approaches taken to verb-learning, and the problem of overgeneralization that I discuss in detail. Chapter 2 describes the acquisition process of control and raising verbs where the problem of overgeneralization does not arise. Chapter 3 presents a true case of the problem of overgeneralization: the acquisition of causatives. I show that overgeneralization arises when there is sufficient evidence in the input in accordance with the Sufficiency Principle (Yang 2016). Chapter 4 provides an outline of an experimental design that can empirically test the Sufficiency Principle, which I defend throughout the proposal. Finally, Chapter 5 presents a brief overview of the acquisition of passives.

2. Background

To discuss the problem of overgeneralization and the acquisition of verb argument structure throughout the proposed dissertation, I first provide an overview of the assumptions made throughout. I discuss the problem of overgeneralization in more detail in Section 2.1. Section 2.2 discusses previous theories of verb learning, which I deal with throughout the proposed dissertation. Section 2.3 presents both the Tolerance Principle and the Principle of Sufficiency in brief, and Section 2.4 lays out the main assumptions and ideas explored in the proposed dissertation.

2.1. The Problem of Overgeneralization

The problem of overgeneralization attracted research on language acquisition over the past several decades (Baker 1979; Berwick 1985; Bowerman 1982; Pinker 1989; Yang 2016; i.a.). In learning the rules of their language, children at times make overarching generalizations resulting in a grammar that is a superset of the adult grammar (Berwick 1985). We are then faced with the following problem: how do children unlearn these generalizations in the absence of negative evidence in the input? This classical subset problem in question is represented in the diagram below:
Figure 1: The problem of overgeneralization.

Figure 1 illustrates the problem of retreating from the superset grammar \( G' \) to the subset grammar \( G \). A linguistic example of the problem can be found in the case of the dative alternation (Baker 1979; Pinker 1989; Yang 2015). Some ditransitive English verbs, but not all, alternate between the double object construction or taking a PP argument, as shown below:

(5) a. John gave the book to Bill.
    b. John gave Bill the book.
(6) a. John donated a painting to the museum.
    b. *John donated the museum a painting.

Although give and donate are similar in meaning, the former can occur in either construction, while the latter only takes a PP argument. Children who assume that donate can occur in a double object construction as well would eventually have to retreat from this superset hypothesis.

2.2. Theories of Structural Learning

The mechanisms of word and verb learning proposed in the literature vary in several respects. One key point of divergence stems from the kind of equipment the learner is initially endowed with. The notion of syntactic bootstrapping, for instance, plays on the idea that the structure in which a word occurs, allows the child to construe an appropriate meaning for the word (Gleitman 1990). The ability of the learner to comprehend structural relationships leads to the acquisition of word meanings. Under this line of approach, children learn verbs along with their argument structure early on and use them appropriately (Borer and Wexler 1987; Crain and Lillo-Martin 1999; Gleitman and Newport 1995; Naigles 1990; Pinker 1984). This early awareness is claimed to be due to the innate knowledge of the relationship between syntactic structures and the meanings they are associated with. Thus, it is argued that certain rules are not learned, but come innately endowed (e.g. Lidz, Gleitman, and Gleitman 2003). Other models do not expect the learner be able to identify and learn the full range of word meanings due to the learner’s lack of understanding of the linguistic structure (Golinkoff, Shuff-Bailey, Olguin, and Ruan 1995; Hollich et al. 2000; Maguire, Hirsh-Pasek, and Golinkoff 2006). These models claim that verbs learned early on are only learned and used in specific ways, and their meanings do not extend to apply to a large range of subjects and objects associated with the verb. Models proposing the idea that child language acquisition is conservative argue that children do not extend their observations from one word to another (Brooks and Tomasello 1999a; MacWhinney 2004; Theakston, Lieven, Pine, and Rowland 2001; Tomasello 2000). In verb learning, chil-
dren observing the argument structure for one verb would not extend a similar hypothesis to other verbs. Such theories fall under the umbrella of usage-based approaches, which I discuss in more detail later on.

The proposed dissertation engages with the literature discussing the level of productivity present in child language acquisition in relationship to verb learning. I show that the learner need not possess an innate knowledge of the rules in their language in order to use it productively. Adopting Yang’s (2016) Sufficiency Principle, I show how the input can be used to learn productive rules when there is sufficient positive evidence. Moreover, I also show that children do indeed adopt a conservative lexical learning strategy when there is insufficient evidence. Using the case of the causatives in Chapter 4, I illustrate in detail how children do indeed overgeneralize and form productive rules when there is sufficient positive evidence in the primary linguistic data. By doing so, I stray from theories which assume that learning is necessarily conservative. I also show that the properties of verbs can be learned from structural information in the input, and therefore, one does not need to rely on innate mechanisms for these cases at least.

The proposed dissertation also discusses how the learner uses positive evidence available in the primary linguistic data. The literature varies in this respect with a large body of work revolving around theories using (indirect) negative evidence (Ambridge, Pine, Rowland, and Young 2008; Bowerman and Croft 2008; Tomasello 2000; i.a.). Theories appealing to indirect negative evidence consistently invoke entrenchment and preemption as a learning mechanisms. The notion of entrenchment assumes that learners do not assume properties for verbs (or any other linguistic element) when they have not heard the verb displaying that property. Over time, the verb is then said to be entrenched only in the forms in which it has been used. Entrenchment has been invoked in the acquisition of control and raising (Becker 2014) construction and in the acquisition of causatives (e.g. Ambridge, Pine, Rowland, and Young 2008). I discuss these approaches in more detail in Chapters 3 and 4 respectively. For instance, in addressing the acquisition of the causative rule, this line of work predicts that verbs that occur more frequently are more susceptible to entrenchment. I provide evidence against this approach by showing that verb frequency alone cannot account for the overgeneralization and the retreat from overgeneralization. Although I do not deny the overall effect of entrenchment and frequency, I argue that entrenchment alone cannot account for the errors in overgeneralization. On the other hand, preemption accounts approach the overgeneralization problem by claiming that erroneous verb forms are replaced with different verbs conveying the same meaning. Here, children are said to consistently mistake the meanings of verbs and other structural properties, causing them to make errors. When the right verb with the right structural property is learned, the errors disappear. This mechanism has been used to account for learning causative verbs (Bowerrman and Croft 2008; Pinker 1989; i.a.). I show that preemption cannot adequately result in retreat from overgeneralization, and moreover, there appears to be no effect of preemption on retreat from causative errors overall (Ambridge 2008; Bowerman and Croft 2008).

To discuss how the input reflects the stages of language development, I also examine the case of passives. The maturation hypothesis claims that children do not develop A-chains until the age of 5 or 6. Raising verbs and passives are phenomena that require A-chain, and hence, are said to be acquired later on. Passives are argued to be developed late in English (e.g. Borer and Wexler 1987; Crawford 2012; Hirsch and Wexler 2006); however, there is some counterevidence from Sesotho (Demuth 1989) claiming that passives are not universally acquired late. The proposed dissertation aims to address this claim by comparing the frequency of the Sesotho passive in the input versus the English passive. I predict that the difference between the emergence of the passives in the two languages should be reducible to the difference in the occurrences of the passive in the input, as there also exists empirical evidence suggesting that children’s passives are productive (Brooks and Tomasello 1999b; Pinker, Lebeaux, and Frost 1987).
2.3. Conceptual Framework

Throughout the proposed dissertation, I will defend the idea that a rule for any given linguistic class is not always generalizable. Rules are only generalizable when there is sufficient positive evidence in the input. I adopt the Tolerance Principle and the Sufficiency Principle (Yang 2005, 2016) as a way of determining how much positive evidence in the input is sufficient to generalize a rule, or to say that a rule is productive in language. The aforementioned principles that allow us to calculate the number of positive members required to generalize a rule can be found in (7) and (8) below:

(7) “Tolerance Principle: If \( R \) is a productive rule applicable to \( N \) candidates, then the following relation holds between \( N \) and \( e \), the number of exceptions that could but do not follow \( R \):
\[ e < \theta_N \text{ where } \theta_N := N/\ln N \] (Yang 2016:10)

(8) “The Principle of Sufficiency: Let \( R \) be a generalization over \( N \) items, of which \( M \) items are attested to follow \( R \). \( R \) can be extended to all \( N \) items iff:
\[ e < \theta_N \text{ where } \theta_N := N/\ln N \] (Yang 2016, :140)

The above formulas essentially state that in order for a rule to be generalizable for a class of \( N \) members, there can be no more than \( N/\ln N \) exceptions. If a rule has more exceptions than \( N/\ln N \), then each member of the class will have to be lexically learned. The intuition behind the Tolerance Principle can be captured by the following example: imagine that we are on a Pokémon capturing expedition on a foreign island, where we spot 10 new Pokémon. We notice that 8 out of these 10 Pokémon fly; therefore, we are likely to conclude that all Pokémons of this type fly. We are unlikely to reach the same conclusion if only 2 out of the 10 Pokémon are observed to fly.\(^2\) In the proposed dissertation, I defend the idea that a rule is generalizable if there are enough positive members following a rule.

Both the Tolerance Principle and the Sufficiency Principle allow us to determine the number of positive members needed within a class for a rule to be generalizable. The difference between the two is in terms of the decision made by the learner. For instance, in a class with 10 members, if the learner has observed a property \( p \) for 8 of those members, then the learner can conclude that the rule is generalizable as \( 2 < N/\ln N \). The Tolerance Principle, in this case, tells us that we would expect the learner to assume \( p \) for a new 11th member of the class that the learner has not yet encountered. No claim is made by the Tolerance Principle regarding the other two members of the class of 10 where the learner has encountered the member in the input, but has not observed \( p \). In contrast, the Sufficiency Principle allows for us to extend \( p \) to the other two members based on positive evidence for the other 8.

The difference between the Tolerance Principle and the Sufficiency Principle is important in addressing the errors of overgeneralization in child speech. These errors occur when the learner does not observe a property for certain members of a class, but extends this property to those members based on the observation that other members of the class show this property. In the proposed dissertation, I investigate verbs, and verb classes, and ask whether or not a rule for a given class of verbs is generalizable to the other verbs within the same class. Here, I invoke the Sufficiency Principle. For the Tolerance Principle, the learner may have encountered evidence that rule does not apply to certain members of the class. However, if the number of exceptions to this rule fall below the threshold of the Tolerance Principle, the learner will still acquire this rule productively and extend it to a new member that enters the class. To consider a hypothetical example, let us assume a class with 10 members where 4 members show a certain property. If we follow the Sufficiency Principle, 4 out of 10 is insufficient evident to assume that the rule is generalizable.

\(^1\)The reader is referred to Yang (2016) for details regarding the derivation of the Tolerance Principle and the Sufficiency Principle.

\(^2\)See Yang (2016) for other linguistic applications of the Tolerance Principle.
to the other 6 members in the class. If there is positive evidence for 9 out of 10 members for this property, there would be sufficient evidence for the learner to generalize within the class. Note that in this case, they have not encountered any positive evidence that the one remaining member does not follow the rule. This is not always the case. At times, the learner may encounter positive evidence indicating that some members do not follow the rule under consideration, as in the case of past tense formation that consists of some irregular verbs. The rule can still be generalizable in these cases. Let us assume for the class of 10 members that the learner has positive evidence that 9 follow a rule and positive evidence that 1 does not. In this case, the number of exceptions is below the threshold of the Tolerance Principle, and the rule is productive. Therefore, if the learner encounters a new 11th member of this class, they will assume that this member follows the rule in the absence of positive evidence. I assume this distinction between the Tolerance and Sufficiency Principles throughout the proposed dissertation.

Finally, in order to understand the problem of overgeneralization in the cases considered here, verbs must be viewed as part of a larger class from which the overgeneralization may or may not arise. We are only faced with the task of retreating from an overgeneralization when a property within a certain class is generalizable to other members of the class. I show that this is the case for causatives, but not for control and raising verbs. When there is insufficient evidence for generalization, the property must be learned in isolation for each individual class member. I show that in the cases of overgeneralization, a rule can be generalizable early on in the acquisition process, and then fail to be generalizable in later stages. This accounts for the retreat from overgeneralization that results in the grammar we find for adults. Moreover, as rule-learning is a primitive part of language acquisition, at this stage, I propose that learners seek subclasses where there is a generalizable rule to be found.

2.4. Proposal

The dissertation proposes the following regarding the acquisition of verb argument structure:

1. Language is learned from positive evidence in the input.
2. Learners form verb classes based on their structural properties and meaning.
3. Learners overgeneralize properties over an entire class of verbs when there is sufficient positive evidence in the input.
4. When there is insufficient evidence to form a generalizable rule, the learner searches for subclasses where a generalizable rule may be found.
5. Verb argument structure is learned both from structural and situational cues.

3. The Acquisition of Control and Raising Verbs

In this chapter, I describe the process of acquiring control and raising constructions. The acquisition of these constructions is interesting because, on the surface, they can appear to be identical to the naïve learner.

(9) a. Johni wants [PROi to like syntax]. (control)
    b. Johni seems [ti to like syntax]. (raising)

This chapter draws heavily from Irani and Yang (in prep).
c. John began [PRO; to like syntax]. (control)
d. John began [t; to like syntax]. (raising)

In (9a), want is a control predicate, which means that the DP John does not raise from within the infinitival clause; there is a PRO subject instead. Seem, in contrast, is a raising verb that requires John to raise to the specifier of the highest TP. Raising verbs like seem do not assign a theta-role to their external argument, unlike control verbs. In addition, there are also ambiguous verbs like begin, which can either be found in a control frame as in (9c) or a raising frame as in (9d).

Given these three kinds of predicates: pure control verbs like want, pure raising verbs like seem, and ambiguous ones like begin, a learnability problem has been forefronted in the literature (Becker 2006). Since some verbs such as begin are both raising and control (9c)–(9d), what would prevent the learner from concluding that all control verbs are also raising? Furthermore, if we overgeneralize a raising structure to all control verbs, then how can the learner retreat from this superset hypothesis in the absence of negative evidence? The potential problem here is that of retracting from the overgeneralization of analyzing all predicates as raising, when some of the predicates are purely raising, while the others are both raising and control. Becker (2006, 2014) proposes that the problem of overgeneralization here can be resolved by an animacy distinction between raising and control verbs: raising verbs allow both inanimate and animate subjects more frequently than control verbs, which tend to primarily only take animate subjects. The evidence for the learner to retrieve from the overgeneralization, then, is the lack of inanimate subjects that occur with control verbs. Consequently, this approach invokes the use of indirect negative evidence, which I argue against in this proposal.

I argue instead that control is acquired prior to raising, and that the problem of overgeneralization does not arise if the adopted theory of generalization is reasonably constrained. No indirect negative evidence is needed for the learner to arrive at the correct differentiation between the two classes, as sufficient positive evidence is available in the input.

3.1. A Putative Learnability Puzzle

Becker (2006) considers, and eventually rejects, the possibility that children initially assume that all verbs that take an infinitival complement are control verbs. If children initially assume that all verbs that take infinitival complements are control verbs, expletives are one way to identify which ones are raising because they indicate that no theta-role has been assigned to an external argument introduced by a verb. Control verbs, unlike raising verbs, are incompatible with expletive subjects. However, Becker argues against this learning mechanism on the basis of verbs like begin that fall into both the control and raising categories. If the learner analyzes begin as a pure raising verb on the basis of expletive subjects, as in it began to rain, then the learner would have no positive evidence to correctly also identify it as a control verb later on. If the learner assumes both a raising and a control structure for begin, then why wouldn’t the learner assume that pure raising verbs like tend or seem are also optionally control verbs like begin? In order to circumvent this potential problem, Becker rejects the hypothesis that children initially assume that all verbs which select an infinitival complement are all control verbs, and that the raising verbs are identified via expletive subjects. Instead, she argues that the children can distinguish between the two classes by observing the number of inanimate subjects used with control and raising predicates; control predicates are said to occur with a lower number of inanimate subjects than raising predicates.

Becker (2006, 2014) contends that any analysis of the acquisition of raising and control predicates, must address the problem of learning pure raising, pure control, and ambiguous predicates without overgeneralizing that all predicates are ambiguous between raising and control. A visualization of the problem can be seen in Figure 2 below:
As illustrated in Figure 2, the problem any analysis of the acquisition of control and raising verbs faces is that of singling out pure control and raising verbs, while still allowing for a class of verbs that fall into both categories; i.e., when learning the raising form of a verb, if a verb can be both raising and control, how does the child retreat from this overgeneralization that the verb hypothesized to be both control and raising is in fact a pure raising verb? The rest of this chapter argues that the problem of overgeneralization for ambiguous predicates does not arise, and children do not initially interpret control verbs as raising. I also provide a quantitative evaluation of Becker’s indirect negative evidence approach in Section 3.3. The following section provides an overview of the developmental literature on children’s command of raising and control constructions.

### 3.2. Evidence for Early Control

Early work on control showed that children between the ages of 3-8 years overall have knowledge of the construction to varying degrees (Cairns, McDaniel, Hsu, and Rapp 1994; Goodluck 1981; Goodluck, Terzi, and Díaz 2001; Hsu, Cairns, and Fiengo 1985; Maratsos 1974; McDaniel, Cairns, and Hsu 1990/91; Sherman and Lust 1993). These studies have generally shown children below the age of 5 to possess control structures (Borer and Wexler 1992). For instance, Sherman and Lust (1993) found that in sentences without multiple antecedents, children as young as 3 years old pass comprehension tests. Additionally, in crosslinguistic work, Goodluck, Terzi, and Chocano Diaz (2001) illustrate that 4-5 year old children show the ability to comprehend control sentences in Spanish and Greek.

This line of work has furthered our understanding of control in child grammar, and in addition, more recent work explicitly compares the acquisition of raising to control, where it has been found that control is acquired prior to raising before the age of 4 (Hirsch 2011; Hirsch, Orfitelli, and Wexler 2007; Hirsch and Wexler 2004, 2007). For example, Hirsch and Wexler (2007) tested children between the ages 3:0 and 5:11 and found that they were overall above 80% correct on control structures, whereas children performed at chance at about 45% on raising conditions. In addition, Hirsch, Orfitelli, and Wexler (2008) tested children in age groups from 3 to 7 years (10 children per age group) using a truth-value judgment task, and arrived at results consistent with their earlier findings.
Table 1: Performance on control versus raising conditions (From Hirsch, Orfitelli, and Wexler 2008, Table 3)

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Control</th>
<th>Raised</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>100%</td>
<td>3%</td>
</tr>
<tr>
<td>4</td>
<td>100%</td>
<td>36%</td>
</tr>
<tr>
<td>5</td>
<td>100%</td>
<td>34%</td>
</tr>
<tr>
<td>6</td>
<td>99%</td>
<td>68%</td>
</tr>
<tr>
<td>7</td>
<td>98%</td>
<td>71%</td>
</tr>
</tbody>
</table>

The data in the table above are extracted from Hirsch, Orfitelli, and Wexler (2008), showing that children perform above chance on control conditions early on, but not on raising conditions. In another experiment testing the comprehension of *seem*, Hirsch and Wexler (2007), show that across all children tested under the age of 7, the performance for each age group was only at chance level.

3.3. Indirect Negative Evidence

We have already found reasons so far to suspect the claim that raising is acquired before control. To recap, Becker (2006) argues that the existence of some control predicates that are also raising can lead the learner to overgeneralize an optional raising counterpart to all control verbs or vice versa. Under this logic, a learnability problem arises from which the learner could not retreat without negative evidence. Therefore, raising is said to be acquired before control to avoid the learnability puzzle, and to account for the empirical results of children accepting sentences like *the flower wants to be pink* (Becker 2006). In particular, control verbs with inanimate subjects are said to be analyzed as raising in the early stages of acquisition. Thus, Becker argues that if raising predicates often occur with both animate and inanimate subjects, and control predicates primarily occur with animate subjects, children learn that a verb is a control verb over time when they do not hear inanimate subjects with a verb. Crucially, it is the lack of inanimate subjects that leads the learner to treat a verb as control. The reasoning here is that if a control verb does not occur with enough inanimate subjects, the learner assumes that it cannot occur with inanimate subjects overall. Equating this lack of evidence with evidence results in an indirect negative evidence approach. Following Becker’s suggestion, we find in this section that the rate of inanimate subjects in the input data does not differ enough between the three kinds of predicates to allow for learning from indirect negative evidence. The data in the input is not adequate enough to serve as the primary learning mechanism in this case. Below, I review the plausibility of children learning from tendency of raising predicates to select for more inanimate subjects than control predicates.

Becker (2014) determined the rate of inanimate subjects with raising, control, and ambiguous predicates by examined the mother’s speech for Adam, Sarah, and Eve in the Brown (1973) corpus in CHILDES (MacWhinney 2000). The tables (from Becker 2014, Table 6.1) list the number of animate and inanimate subjects that occur with each type of predicate. We see in these tables that all three types of predicates occur overwhelmingly with animate subjects, and my own examination of the data also reveals the same.

Let us first take a look at the data in child-directed speech (CHILDES) for raising predicates.
Table 2: Inanimate subjects with raising verbs (from Becker 2014, Table 6.1)

<table>
<thead>
<tr>
<th>Raising</th>
<th>Animate</th>
<th>Inanimate</th>
<th>% Inanimate subjects</th>
</tr>
</thead>
<tbody>
<tr>
<td>seem</td>
<td>4</td>
<td>6</td>
<td>60%</td>
</tr>
<tr>
<td>used (to)</td>
<td>45</td>
<td>5</td>
<td>10%</td>
</tr>
<tr>
<td>going (to)</td>
<td>1197</td>
<td>58</td>
<td>4.6%</td>
</tr>
<tr>
<td>total</td>
<td>1246</td>
<td>69</td>
<td>5.2%</td>
</tr>
</tbody>
</table>

In the table above, we see that the overall rate of the use of inanimate subjects is 5.2%. We also see that two out of the three verbs, used to and going to, are used with a low percentage of inanimate subjects, even though under an animacy-based approach, we might expect that inanimate subjects should occur with raising predicates more frequently. In addition, we find in CHILDES that seem, which occurs with inanimate subjects at a rate of 60% in the Brown corpus, occurs with inanimate subjects at a lower rate of around 30% more generally. The lower rate of inanimate subjects with seem brings down the rate of inanimate subjects with the class of raising verbs overall, bring it closer to that of the control class shown below. We see that control predicates are also present in the data primarily with animate subjects.

Table 3: Inanimate subjects with control verbs (from Becker 2014, Table 6.1)

<table>
<thead>
<tr>
<th>Control</th>
<th>Animate</th>
<th>Inanimate</th>
<th>% Inanimate subjects</th>
</tr>
</thead>
<tbody>
<tr>
<td>want</td>
<td>405</td>
<td>2</td>
<td>0.5%</td>
</tr>
<tr>
<td>like</td>
<td>210</td>
<td>0</td>
<td>0%</td>
</tr>
<tr>
<td>try</td>
<td>86</td>
<td>0</td>
<td>0%</td>
</tr>
<tr>
<td>love</td>
<td>10</td>
<td>0</td>
<td>0%</td>
</tr>
<tr>
<td>hate</td>
<td>1</td>
<td>0</td>
<td>0%</td>
</tr>
<tr>
<td>total</td>
<td>712</td>
<td>2</td>
<td>0.3%</td>
</tr>
</tbody>
</table>

Finally, the rate of inanimate subjects for ambiguous predicates may be expected to fall in between that of control and raising predicates, but that prediction is not borne out. We find that the class of ambiguous predicates is not readily distinguishable from the pure control and raising class.

Table 4: Inanimate subjects with ambiguous verbs (from Becker 2014, Table 6.1)

<table>
<thead>
<tr>
<th>Ambiguous</th>
<th>Animate</th>
<th>Inanimate</th>
<th>% Inanimate subjects</th>
</tr>
</thead>
<tbody>
<tr>
<td>start</td>
<td>4</td>
<td>0</td>
<td>0%</td>
</tr>
<tr>
<td>begin</td>
<td>1</td>
<td>0</td>
<td>0%</td>
</tr>
<tr>
<td>need</td>
<td>38</td>
<td>4</td>
<td>9.5%</td>
</tr>
<tr>
<td>total</td>
<td>43</td>
<td>4</td>
<td>8.5%</td>
</tr>
</tbody>
</table>

In Table 4, we see that the ambiguous predicates start and begin are vanishingly rare in the data, and they do not occur with inanimate subjects. Moreover, the overall use of inanimate subjects is only 8.5%. Fisher’s exact test on the overall use of inanimate subjects with pure raising verbs and ambiguous verbs reveals that the two overall proportions when compared to each other are not significantly different ($p > 0.1$). The numbers noted for the ambiguous predicates are not distinct from the numbers for the pure raising
predicates. In sum, there is a tendency for raising predicates to occur with inanimate subjects, but most verbs do not occur very frequently in the data, and when they do, they occur mostly with animate subjects.

What we have seen thus far is that the animacy approach claims that children note the predicate’s level of selectivity for animate subjects, and conclude that the higher a predicate’s selectivity for taking animate subjects, the greater the likelihood of it having a control structure. This analysis essentially requires that children form a generalization when they do not see inanimate subjects sufficiently frequently with certain predicates. This proposal falls under the umbrella of indirect negative evidence due to the fact that the child is said to generalize based on the lack of evidence. Such an analysis must explicate the environments in which overgeneralizations are not made (Pinker 1989, Yang 2015). Learning control and raising predicates under this kind of indirect negative evidence approach proves to be a non-trivial task. Using the case in question, I show that learning these predicates from indirect negative evidence is not straightforward.

As seen earlier, the number of inanimate subjects with all three types of predicates is small. An indirect negative evidence approach must show that these statistical disparities must be prominent enough in the input to be applicable for use to the learner. To determine whether the statistical differences are large enough to be usable by the learner, I have estimated these probabilities using the numbers Becker (2016) provides us with. However, I note here that the learner does not know a priori the percentage of inanimate subjects with the three kinds of predicates; an actual learning model must estimate the probabilities and use it to draw statistical inferences at the same time. This kind of learning would amount to the best case scenario for an indirect negative evidence learner.

The task of distinguishing between the three kinds of predicates given the use of inanimate subjects is akin to the task of trying to distinguish between two coins with different probabilities of showing heads by flipping them repeatedly—sufficiently many times so that their differential probabilities can be reliably detected in the sample. For example, let us assume two coins A and B with probabilities of showing heads at 0.4 and 0.6 respectively. If we flip the coin once, regardless of whether the outcome is heads or tails, we will not be able to reliably guess the nature of the coin. The more we flip the coin, the more likely it is that we will be able to confidently guess whether we have coin A or B. If we flip the coin very many times, the probability distributions are going to cluster around the true means of the two coins. The task to distinguish between the two coins, on the other hand, cannot be done effectively with a only a few coin tosses. Under the animacy-based approach, the learner is faced with the same kind of problem, but with values that are closer together than in this example.

Hence, as the learner, we would like to determine, given the number of inanimate subjects used, whether the predicate is raising, control, or both over $N$ number of trials. As in the coin example, generally speaking, the more times we see a predicate used either with an animate or inanimate subject, the more likely we are to be able to confidently tell the predicates apart. Let us suppose that we are trying to determine whether a Predicate X is of type A with the rate of inanimate subjects at 0.2, or whether it is of type B with the rate of inanimate subjects at 0.5. Taking these rates of inanimate subjects into account, we can calculate the probability that a predicate is either of type A or B. At each instance of encountering the predicate, we will either see it with an animate or inanimate subject. This process is binomial, and we can, therefore, do a binomial test at each trial to check whether the number of times that a predicate was heard with an inanimate subject was significantly different; i.e., whether at any point it could be determined that predicate X is of one type or the other. We can then summed up the probabilities of the predicate at each trial where the result was significant. The result is the overall probability of us determining whether predicate X is of type A or B, given the number of times we have encountered it. For instance, if we encounter predicate X 10 times, we get the following:
Table 5: P(i, N, a) and P(i, N, b) indicate the probability of a predicate being of type A with the rate of inanimate subjects at 0.2 or of type be with the rate of inanimate subjects at 0.5 at each trial. i indicates the number of times a predicate has occurred. A binomial test indicated by bt(i, N, a) and bt(i, N, b), shows whether the number of times a predicate occurred with an inanimate subject was significant in order to tell whether a predicate is of type A or B. The sum of the probabilities when the binomial test showed $p < 0.05$ reveals the cumulative probabilities over the total number of trials. A total of 10 trials shows that there is only a 41% chance of detecting the predicate type when it is of type A, and a 62% chance of detecting it when it is of type B.

<table>
<thead>
<tr>
<th>i</th>
<th>P(i, N, a)</th>
<th>bt(i, N, a)</th>
<th>P(i, N, b)</th>
<th>bt(i, N, b)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0.107</td>
<td>0.228</td>
<td>0.001</td>
<td>0.002</td>
</tr>
<tr>
<td>1</td>
<td>0.268</td>
<td>0.698</td>
<td>0.01</td>
<td>0.021</td>
</tr>
<tr>
<td>2</td>
<td>0.302</td>
<td>1.0</td>
<td>0.044</td>
<td>0.109</td>
</tr>
<tr>
<td>3</td>
<td>0.201</td>
<td>0.43</td>
<td>0.117</td>
<td>0.344</td>
</tr>
<tr>
<td>4</td>
<td>0.088</td>
<td>0.121</td>
<td>0.205</td>
<td>0.754</td>
</tr>
<tr>
<td>5</td>
<td>0.026</td>
<td>0.033</td>
<td>0.246</td>
<td>1.0</td>
</tr>
<tr>
<td>6</td>
<td>0.006</td>
<td>0.006</td>
<td>0.205</td>
<td>0.754</td>
</tr>
<tr>
<td>7</td>
<td>0.001</td>
<td>0.001</td>
<td>0.117</td>
<td>0.344</td>
</tr>
<tr>
<td>8</td>
<td>0.0</td>
<td>0.0</td>
<td>0.044</td>
<td>0.109</td>
</tr>
<tr>
<td>9</td>
<td>0.0</td>
<td>0.0</td>
<td>0.01</td>
<td>0.021</td>
</tr>
<tr>
<td>10</td>
<td>0.0</td>
<td>0.0</td>
<td>0.001</td>
<td>0.002</td>
</tr>
</tbody>
</table>

The rows in bold indicate when one can decide that X is either a type A or type B predicate. If we add up the probabilities, we find that if a predicate is of type A, there is only a 41% chance that we can detect it, and a 62% chance if it is of type B. In this example, we find that we can reliably detect the type of predicate if we encounter it 37 times.

Now that we have seen an example of how the different rates of inanimate subjects can be used, we can turn to the actual problem at hand. Assuming $a = 0.003$ for the rate of inanimate subjects expected with control predicates and $b = 0.052$ for the rate of inanimate subjects expected with raising predicates (from Tables 2 and 3), we can perform a binomial test to find the total number of instances of any given predicate a child would have to hear in order to reliably distinguish the classes. Essentially, we are calculating the number of trials needed in order for the child to be certain whether a predicate is raising or control, or an ambiguous or pure raising predicate. Given that the rates of inanimate subjects for these classes are fairly close, a few instances alone are not enough to accurately determine which class the predicate belongs to. Just like in examples presented earlier, the more instances of a predicate the child hears, the more reliable the distinction between the classes. Taking into account the rate of inanimate subjects from Becker’s (2014) table, we can calculate the probability of determining which class the predicate falls into.\(^6\)

The result of performing these calculations on the control, raising, and ambiguous predicates showed the need for about 190 instances in order to disambiguate between pure control and pure raising with a 99% confidence interval. With a 95% confidence interval, the child would need to hear 90 instances of a predicate to make such a decision. In other words, the probability of confidently determining which predicate the learner has encountered approaches 1 when the learner has heard the predicate about 90 times. The probability of being able to confidently distinguish between pure control and raising predicates when the predicate has occurred $N$ times with a 95% confidence interval is illustrated in Figure 3. As can

\(^6\)The code for the calculations can be found in the appendix.
be seen from the graph, the probability of confidently determining is close to 1 only between 80 and 120.\footnote{The dips in the curves indicate the points where it becomes more difficult to detect the predicate type. For instance, if the learner observes some inanimate subjects early on, they may get increasingly confident that the predicate is of type B. However, over time, when they primarily observe the predicate occurring with animate subjects, the probability that this predicate is now of type A also increases. This in turn adversely affects the probability of the predicate being of type B, and we observe a dip in the curve.}

![Graph showing probability of predicate type detection over number of trials.](image)

**Figure 3**: Number of occurrences needed to distinguish control from pure raising predicates with a 95% confidence interval.

Moreover, it is even harder to distinguish between the pure raising class and the ambiguous predicates class. Here, the rate of inanimate subjects for pure raising would be $a = 0.052$, and the rate of inanimate subjects for ambiguous predicates would be $b = 0.085$ (Table 4). In this case, with a 99% confidence interval, the number of instances of a predicate the child must hear to differentiate between the classes is 1258, and we know that only a few predicates occur that often in the data. With a 95% confidence interval, at least 633 instances of the predicate have to be observed. The probability of being able to distinguish between pure raising and ambiguous predicates when the predicate has occurred $N$ times with a 95% confidence interval is illustrated in Figure 4.

As Figure 4 illustrates, a predicate has to be heard several hundred times in this case to be able to determine which class it falls into, and if we look at the tables for raising and control, many of the predicates do not occur anywhere close to that many times.

Given the low frequency of evidence in the input, under an indirect negative evidence approach using the animacy-based tendency, children are predicted to learn these verbs much later than they actually do. For instance, the verb *choose* is used accurately by children as young as 3 years old. This verb occurs 15 times in the input comprising of the combined CHILDES data. Even if the data examined was roughly equivalent to what the average learner hears in a year, we would arrive at an incorrect estimation that children would learn *choose*, a pure control verb, around the age of 7.
Figure 4: Number of occurrences needed to distinguish ambiguous predicates from pure raising predicates with a 95% confidence interval.

Not only must we appeal to large numbers in the case of indirect negative evidence, we must also recall that in practice, the probabilities of inanimate subjects associated with each class, presented earlier in Tables 2-4, are not known to the learner. In Becker's (2014) approach, the (Bayesian) learning model must estimate the probabilities of inanimate subjects for each class while calculate the posterior probabilities of a verb being raising, control, or ambiguous. Not surprisingly, Becker reports that the model fails to classify verbs correctly, citing data sparsity as one of the main reasons. The results I presented show that even if the learner were to know the true distributions of animacy for verb class, language offers nowhere near the requisite quantity of evidence for children to successfully acquire raising and control verbs.

In the following subsection, I propose an alternative solution to an animacy based approach: generalization from sufficient positive evidence. I adopt the Principle of Sufficiency (Yang 2016) as a mechanism for the child to determine when to generalize. The Principle of Sufficiency shows us that there is no condition under which ambiguous predicates are overgeneralized; therefore, the learnability puzzle does not arise. Pure raising predicates are learned from non-referential expletive subjects, which unambiguously differentiate themselves from control predicates.

3.4. Generalization from Positive Evidence

In this section, I show how the learner can arrive at the distinctions between raising and control from positive evidence in the input. I argue that this positive evidence manifests itself in the form of non-referential expletive subjects.\(^8\) I aim to show here that expletive subjects are a more reliable indicator of the difference between the three types of predicates than subject animacy. I also show that the learnability

\(^8\)Throughout my analysis, I use the term “expletive” to include the constructions in null subject languages in which the grammatical subject position is null. I am agnostic as to whether that position is occupied by an unpronounced expletive, or is simply absent.
puzzle resulting from the overgeneralization of ambiguous predicates does not arise.

In Section 3.4.1, I discuss in detail how the problem of overgeneralization does not arise in learning control and raising predicates. In this section, I first argue for the use of expletive subjects as indicators of the differences between control and raising predicates. Next, I present the number of ambiguous, raising, and control predicates to show that the number of ambiguous or raising predicates are not enough to be generalizable. In Section 3.4.2, I describe how ambiguous predicates are learned distinctly from pure raising predicates using positive evidence in the input.

3.4.1. Positive Evidence for Learning Raising and Control

This section describes the nature of non-referential expletive subjects in the input, and how children use this data to learn raising and control predicates. I propose the following learning mechanism: potential raising or control predicates are first identified when the verb takes an infinitival complement. Through the selection of a non-finite complement, the learner begins to consider a raising or control structure. The distinction between the raising, control, and ambiguous verb classes are thereafter learned through the use of expletives.

The presence of non-referential expletive subjects is an indicator of a crucial aspect of raising: that the verb does not assign a theta-role to its subject. Moreover, when expletive subjects occur with raising predicates with a CP complement, the subject is low, as in *It seems that John likes syntax*. Such examples serve as evidence to the learner that subjects of raising verbs originate low. All the known properties of raising predicates that differ from control are derivative of these facets of raising verbs. The analysis presented in the proposed dissertation aims to capture the sufficient evidence of these two aspects are present in the input for the learner to generalize from.  

Throughout the chapter, I also assume that when children hear a verb taking an infinitival complement in the input, they initially assume that it is a control construction. The overwhelming empirical evidence presented in Section 2.2 is one reason for assuming that control is acquired first. Another reason for this assumption comes from the fact that a majority of the verbs do introduce an external argument and assign a theta-role to it; the number of verbs that do not introduce an external argument are much fewer in number. Children initially assume a control structure first because they typically see a DP and a verb, where the DP is a possible thematic subject of that verb. Consequently, they assume that verbs generally introduce an external argument because they have learned this property for their language thus far. Similarly, there are claims suggesting that perhaps control is acquired before raising because they are somehow computationally simpler (Frank 1998). In sum, barring Becker (2006), a large body of work suggests that control is acquired before raising.

I examined a total of 66 control and raising predicates\(^{10}\) (Boguraev and Briscoe 1987; Postal 1974) in the infinitival Pred-to-V frame in CHILDES. As I hypothesize that children initially identify potential control or raising verbs through a predicate’s ability to select an infinitival complement, I elected to search these verbs by looking for the infinitival Pred-to-V frame.\(^{11}\) I also ensured that each of the predicates examined occurred at least once in the corpus. There were 42 control, 15 raising,\(^{12}\) and 9 ambiguous predicates in total, which are, in effect, an exhaustive list of these predicates that occur in child-directed speech. For

\(^{9}\)I note here that Becker (2006) does not reject expletive subjects as a useful cue. She states that they can be used as a partial cue to identify pure raising predicates, but under her account, the question of identifying ambiguous and control predicates still remains open.

\(^{10}\)A complete list of the verbs examined is available in the appendix.

\(^{11}\)I did not include control into purpose clauses like *John ran to avoid Mary from confronting him* in this chapter, as their occurrence is more widespread. Although it should be noted that the inclusion of purposes clauses only bolsters my claim as there is more evidence for control.

\(^{12}\)Only subject control and raising to subject verbs were considered in this study.
each of these predicates, I checked whether they were attested with an inanimate or an expletive subject. In order to search through the corpus, I combined data from each child learning English from the CHILDES database; the data reported here are not from a single child. The combined data results in 6 million words of child directed English, which is roughly a year of speech, but we do expect linguistic input differences to vary between children (Hart and Risley 1995).

The results of the corpus search show that 7 out of the 15 unambiguous raising predicates, plus 3 ambiguous predicates, occurred with an expletive subject. These results indicate the low frequency of expletives in the data, which means that we would expect children to acquire raising structures late overall, and learn each raising verb individually when it occurs with a non-referential expletive subject. Only 10 out of the 24 raising predicates examined would, therefore, be learned as raising predicates in this dataset. Below are some examples of expletive there in subject position:

(10) a. suddenly there appeared before her the most beautiful lady she had ever seen. (HSLLD corpus)
    b. there’s gotta be a daddy shark. (Valian corpus)
    c. there happens to be a can right here. (Weist corpus)
    d. and there seems to be an awful lot less competition between them. (Cornell corpus)

English, in addition, has expletive it, which also occurs with raising verbs.

(11) a. it started to rain (Clark corpus)
    b. I think it’s going to be okay now Ross. (MacWhinney corpus)
    c. it’s supposed to get markedly cooler. (MacWhinney corpus)

In examining the data, I went through each instance of it by hand to make sure that it was indeed non-referential. I also used wh-questions as a test to confirm the non-referentiality of it; for example, we cannot have the following question-answer pair for (12):

(12) Q: What started to rain?
    A: # It started to rain.

The results presented above show that non-referential subjects are present in the data as an unambiguous cue for the learner. Furthermore, there is work indicating that children are aware of the presence of expletive subjects (Chen et al. 2016; Wang et al. 1992). For instance, Chen et al. (2016) find that English speaking children as young as 2;8 show evidence of having learned expletive subjects in an elicitation task. The CHILDES database also provides several examples of children having learned expletives. Here, we find instances of expletive use with children as young as 1;9, indicating that children have learned expletives, even though their use may not be consistent.

(13) a. there is no moon (Valian corpus, 1;9)
    b. there’s no song like that (Naima, Providence corpus, 1;9)
    c. its dark outside (Marjorie, Bliss corpus, 2;3)
    d. it’s cold out there (Peter, Bloom corpus, 2;5)
    e. there needs to be another one of (Naima, Providence corpus, 3;1)
    f. there seems to be dust here (Braunwald corpus, 3;2)

Thus, expletive subjects in English are a useful cue for learning raising predicates in English. Expletive subjects are found in child speech at an early age, before age 3 (e.g. Chen, Valian, and Chodrow 2016; Wang, Lillo-Martin, Best, and Levitt 1992), indicating that children are not ignoring them in the input. They are
infrequent in the data, but still present a sufficient and reliable cue. Moreover, none of the control predicates
occur with an expletive subject, but they do occur with inanimate subjects. The examples below show some
instances where control predicates occur with inanimate subjects.

(14)  a. cause then there will be a lot of me talking, and the tape wants to hear you talk. (Weist corpus)
    b. a bad guys sword tried to catch you. (MacWhinney corpus)
    c. and the foolish freight cars refused to back up. (Providence corpus)
    d. the medicine helps to make it better. (Braunwald corpus)
    e. the school bus decided to knock off a few kids. (Hall corpus)
    f. really hmmm mmmmhmmm what else does the fireplace like to eat (Providence corpus)

These examples illustrate that, confirming previous analyses (e.g., Becker 2006), animacy is only a sta-
tistical tendency. The data indicate that animacy is not a reliable enough cue to distinguish raising from
control, especially in light of the sample size necessary given the statistical conditions. Non-referential
expletive subjects, in contrast, are a highly accurate cue. Each of the 10 Pred-to-V predicates identified
belong to the raising class. The child does not encounter any false positives, which shows that if they were
using expletive subjects as cue, they would arrive at the adult grammar. Furthermore, we know that chil-
dren are good at learning non-referential subjects. Even though the formal requirement of using a subject
consistent with the target language is not in place until later stages of development, children are still aware
of the referential content of the subjects even when they are missing. For instance, Wang, Lillo-Martin,
Best, and Levitt (1992) found that English learning children were able to produce non-referential exple-
tives in an elicitation task, but none of the Chinese learning children tested with the same task produce an
overt lexical form in those instances; i.e., they were aware of the non-referentiality of null subjects in their
language, and did not use an ungrammatical overt form in those cases when prompted. Another example
that children can identify subject referentiality comes from Italian learning children, who are adult-like
on pro-drop early on (Valian 1991). Overall, we find that children are not ignoring these cues that are
available to them in the input.

We have seen so far how expletives allow the learner to identify a raising predicate from a purely
control one, but the question of learning ambiguous predicates from pure raising ones still remains open.
This question of how a learner knows that some predicates do not have an optional control counterpart
is what lead us to the learnability puzzle in the first place. How do we prevent overgeneralization of
the ambiguous predicates? I begin to answer this question by turning to the Sufficiency Principle (Yang
2005, 2016), which provides a formal model of rule learning and making generalizations. The sufficiency
principle taken from Yang (2016), as stated in (8) and repeated below in (15), allows us to calculate the
number of positive members required to generalize a rule.

(15) “The Principle of Sufficiency: Let \( R \) be a generalization over \( N \) items, of which \( M \) items are attested
to follow \( R \). \( R \) can be extentended to all \( N \) items if and only iff:
      \[ e < \theta_N \]
      \[ \theta_N := N/\ln N \] \( (\text{Yang 2016:140}) \)

Following the sufficiency principle, we can calculate the number of raising predicates needed for the
learner to reasonably generalize this property to the other predicates. Out of the 66 predicates considered
in this chapter, there exists evidence for only 10 as raising. The sufficiency principle \((N/\ln N)\) requires 49
positive members to generalize over 66 candidates. Given the data, the learner is not predicted to conclude
that the 10 members will be generalized to the entire class of raising and control predicates. Moreover,
there was an expletive subject noted for only 3 of the ambiguous predicates. If 49 of the control predicates
have expletive subjects, then the child would be tempted to assume the reasoning that the 17, which do
not appear with expletive subjects, are also raising predicates. But we are nowhere close to the sufficient
level of positive evidence to generalize so broadly. The following table shows verbs by frequency, and lists
the number of raising and ambiguous predicates at the different stages. By arranging the verbs according
to frequency, we can estimate the order in which children learn these raising and control verbs. As we
can see, at no point in learning these predicates are there more raising or ambiguously raising verbs than
control verbs.

Table 6: Control, raising, and ambiguous verbs by their frequency in CHILDES. Evidence for the
raising or ambiguous predicate rule is never sufficient enough to be generalizable.

<table>
<thead>
<tr>
<th>Verbs</th>
<th>Raising</th>
<th>Ambiguous</th>
<th>All Raising Productive?</th>
<th>Ambiguous Productive?</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 most frequent</td>
<td>3</td>
<td>1</td>
<td>4/10 ✓</td>
<td>1/10 ✓</td>
</tr>
<tr>
<td>20 most frequent</td>
<td>7</td>
<td>3</td>
<td>10/20 ✓</td>
<td>3/20 ✓</td>
</tr>
<tr>
<td>30 most frequent</td>
<td>10</td>
<td>6</td>
<td>16/30 ✓</td>
<td>6/30 ✓</td>
</tr>
<tr>
<td>40 most frequent</td>
<td>13</td>
<td>6</td>
<td>19/40 ✓</td>
<td>6/40 ✓</td>
</tr>
<tr>
<td>50 most frequent</td>
<td>13</td>
<td>8</td>
<td>21/50 ✓</td>
<td>8/50 ✓</td>
</tr>
<tr>
<td>60 most frequent</td>
<td>15</td>
<td>9</td>
<td>24/60 ✓</td>
<td>9/60 ✓</td>
</tr>
</tbody>
</table>

As the table above indicates, the learner does not have sufficient evidence to generalize the raising rule to
the entire class of predicates at any point in learning these predicates. Therefore, the learner will have to
lexically learn the predicates that are raising, on the basis of expletive subjects.

Since the number of ambiguous or pure raising predicates is not large enough for the learner to over-
generalize, the learnability problem does not arise. The learner only overgeneralizes if there are less than
$N/\ln(N)$ exceptions to a rule, and the number of exceptions well exceeds the number of predicates that
show properties of raising. This mistreatment of the problem of generalization in the first place resulted
in the puzzle, which we have now seen does not exist.

Now that I have discussed distinguishing the raising predicates from control ones, let us turn to the
task of identifying the ambiguous predicates from the pure raising ones. The next section addresses the
way in which ambiguous predicates are distinguished from pure raising predicates.

3.4.2. Ambiguous vs. Pure Raising Predicates

Out of the 66 predicates examined, 9 belong to both the raising and control class. These verbs were fail, begin, continue, manage, need, promise, stop, grow, start. There are two properties that vary between am-
biguous and pure raising predicates in the input that can be exploited by the learner. One, ambiguous
predicates, like control predicates, generally do not take a CP complement when there is an expletive
subject. This is not the case for pure raising predicates, as seen in (16) and (17).

(16) *It failed that Bill is happy/went to the store.
(17) It seems that Bill is happy/went to the store.

A second difference between ambiguous predicates and pure raising ones is the rate of expletive sub-
jects they occur with. An ambiguous predicate should, in theory, occur with an expletive subject at a lower
rate than pure raising verbs, as they have an optional control counterpart. This distinction between the
class of ambiguous and pure raising predicates can easily be captured and quantified under a competi-
tions of grammars approach; i.e., under the variational model (Yang 2002, 2004), which I adopt here. The model
is described briefly below before I apply it to the case at hand.
Under this model, the child will select a particular grammar with the probability determined by the evidence in the input. A grammar is punished if the input is incompatible, and rewarded if the data is in line with it. This notion of competition of grammars can be stated as follows:  

(18) “For an input sentence, s, the child:  
(i) with probability $P_i$, selects a grammar $G_i$,  
(ii) analyzes $s$ with $G_i$,  
(iii) if successful, reward $G_i$ by increasing $P_i$,  
otherwise punish $G_i$ by decreasing $P_i." \quad \text{(Yang 2004:453)}$

The variational learning model is different from the Tolerance Principle in that it makes reference to the token frequencies of forms, whereas the Tolerance Principle uses the type frequencies within lexical classes. Another crucial feature of this model is that a grammar, or a parameter value, can potentially never be fully eliminated. Therefore, it is possible that two values of a parameter can be stored. I use this model to determine whether the token frequency of a verb occurring with an expletive varies with the class of the verb. I predict that ambiguous predicates should occur with an expletive subject at a lower rate that pure raising predicates. This prediction is borne out; a pure raising verb like *seem* occurs with far more expletives than an ambiguous verb like *begin*. As a result, *seems* more readily yields to raising properties than *begin*.

The relative frequencies of expletive subjects in the input can be captured by the variational model (Yang 2002), which allows for competition between two forms. Here, both raising and control forms of a verb can compete with each other depending on the data in the input. The quantity of the input experience determines whether the raising form wins out over the control form, or if both forms of the verb are stored. For the ambiguous predicates, the learner learns a probabilistic distribution over two forms: raising and control. Hearing a non-referential expletive in the input points the learner towards the direction that the predicate occurring with an expletive is raising.

To test whether ambiguous predicates did indeed occur less frequently with expletive subjects, as opposed to pure raising predicates, I did a corpus search on the collective data for all English learning children in CHILDES. My test case was that of *begin* versus *seem*, which occurred a comparable number of times in the input, at 464 and 468 total instances, respectively. I found that *begin*, an ambiguous predicate, occurred 5 times only with non-referential *it*, but did not occur with *there*. *Seem*, on the other hand, occurred with non-referential *it* 13 times, and 9 times with *there*. These numbers are summarized below:

### Table 7: Expletive Subjects with *seem* and *begin* in CHILDES.

<table>
<thead>
<tr>
<th></th>
<th>seem</th>
<th>begin</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total occurrences</td>
<td>464</td>
<td>468</td>
</tr>
<tr>
<td>Occurrences in control and raising constructions</td>
<td>266</td>
<td>130</td>
</tr>
<tr>
<td>Occurrences with non-referential <em>it</em></td>
<td>13</td>
<td>5</td>
</tr>
<tr>
<td>Occurrences with <em>there</em></td>
<td>9</td>
<td>0</td>
</tr>
</tbody>
</table>

The total number of non-referential expletive subjects noted for *seem* in raising constructions in CHILDES was 22, while there were only 5 instances of expletive subjects with *begin*. The results from CHILDES

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suggest that the two predicates can be differentiated on the basis of non-referential subject usage. A two-sided chi-squared test with continuity correction also reveals that the two proportions are different ($p < 0.01$).

In contrast, in raising and control constructions, *seem* occurs with 82 inanimate subjects, and *begin* occurs with 30 inanimate subjects, including expletives for both. Thus, the rate of inanimate subjects with *seem*, a raising predicate, is 0.3 and the rate of inanimate subjects with *begin*, an ambiguous predicate is 0.23. I note here that Becker (2014) also found that *seem* occurs with a higher number of inanimate subjects than other raising verbs, although *begin* was not found with the same number of inanimate subjects in her case. My calculations show that even though both *seem* and *begin* occur with inanimate subjects, the difference between the rates of the inanimate subject is not significant ($p > 0.1$). Moreover, performing the same calculations as I did earlier in Section 3.3, we find that about 600 instances of the predicates are required to reliably distinguish between the two classes with a 95% confidence interval. This is seen in Figure 5, which illustrates the number of trials needed to distinguish between two predicates of type A and B with rates of observing inanimate subjects at 0.23 and 0.3 respectively. With a 99% confidence about 720 instances of the predicate must be observed before the learner can determine its class with any certainty. The number of encounters needed for these verbs is more than their total occurrences in all the input in the CHILDES database combined.

![Figure 5: Number of occurrences needed to distinguish pure raising and ambiguous predicates with a 95% confidence interval when using the rate of inanimate subjects from *seem* and *begin* in child-directed speech.](image)

Additionally, in order to control for the relatively smaller size of the CHILDES corpus, I turned to the Corpus of Contemporary American English (COCA), which allows us to better gauge the data available in

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14 *Begin* and *seem* are good test cases for the indirect negative evidence approach as they occur more frequently in the data and with more inanimate subjects when compared to other raising or ambiguous predicates. For instance, *tend* occurs only 15 times in a raising or control construction in the data with 4 inanimate subjects, and *sure* only occurs 26 times in the data with 2 inanimate (expletive) subjects.
the input using the total of over 520 million words of text in the corpus. In COCA, we find that *seem* and *begin* occurred about 278,531 and 234,357 times respectively. As we saw in CHILDES, the token frequency for these predicates is roughly the same, which is precisely why they were chosen to test the relative frequencies of non-referential expletive subjects. I searched the corpus for *there*, and found that while *seem* occurred with *there* 3,514 times, *there* appeared with *begin* only 119 times. These results are summed up in Table 8.

**Table 8: Expletive Subjects with *seem* and *begin* in COCA.**

<table>
<thead>
<tr>
<th></th>
<th>seem</th>
<th>begin</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total occurrences</td>
<td>278,531</td>
<td>234,357</td>
</tr>
<tr>
<td>Occurrences with <em>there</em></td>
<td>3,514</td>
<td>119</td>
</tr>
</tbody>
</table>

The results of 119 versus 3,514 show that there is a clear difference between the number of expletive subjects that occur with ambiguous predicates and those that occur with pure raising ones. A chi-square test with continuity correction also shows that the two proportions are significantly different ($p < 0.01$). A child has more evidence for the raising counterpart of *seem*, than for *begin*; thus, both control and raising forms for *begin* are stored, whereas the raising form for *seem* wins out and its control form is lost; i.e., 3,514 occurrences of a non-referential expletive subject is enough for the learner to conclude that *seem* is a raising predicate, whereas 119 occurrences of a non-referential expletive subject leads the learner to assume that *begin* is ambiguous between having a raising and control structure.

The idea that *begin* and *seem* are learned in relation to the number of expletive uses finds support in children’s production data in CHILDES. Although *begin* and *seem* occur with the same token frequency in the input, the number of expletives with which the predicates are used differ, indicating that children are indeed sensitive to the number of expletives used with a predicate in the input. A search through the combined children’s data in CHILDES returned no uses of *begin* with an expletive subject. In contrast, *seem* is used with an expletive at various ages. A few examples of *seem* used with an expletive subject are shown below:

(19) a. there seems to be dust here (Braunwald corpus, 3;2)
    b. it seems to be (Adam, Brown corpus, 3;7)
    c. it seems like this goes here (EllisWeismer corpus, 3;7)
    d. it seems to me that’s all Graeme is taping today (ATC corpus, Jub, 4;9)
    e. it seemed like they didn’t know where they [their] they were either (Gillam corpus, 6;2)

Throughout this proposal, I have shown that the overwhelming majority of the data is consistent with the child analyzing all potential predicates as being control initially, possibly as a default strategy or due to the simplicity of the grammatical structure (e.g., Wexler 1992). The data also show that the expletive-driven strategy fairs better than the animacy-based model, and moreover, learning ambiguous predicates is not problematic under this analysis. A predicate is identified as raising, iff it appears with an expletive subject or follows other language-specific distributions. My findings are consistent with previous work that argues for the acquisition of control before raising (e.g. Hirsch and Wexler 2007; Sherman and Lust 1993).

The core issue at stake here is the problem of generalization. The learnability problem resulted from the mistreatment of the problem of generalization (Becker 2006). The symptom of such a mistreatment

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15Since examples with non-referential *it* need to be combed through by hand, they were left out here due to the size of the data. For the same reason, I do not provide the rate of inanimate subjects with *seem* and *begin* in COCA.
is the kind of argument that if in some case, even one member in a class shows a certain property, then the learner will need to rule out the likely superset hypothesis that all members in that class show that property. When, in fact, many other members in that class do not. In this instance, “some members” are verbs like *begin*. The problem is taken to be that, apparently, the child would consider all control verbs as candidates for raising.

The Sufficiency Principle provides a general solution for the problem of when to generalize. If there are more than \( N/\ln(N) \) exceptions for \( N \) potential members within a class, then the rule is not productive and the learner does not generalize. Only if a sufficiently large number of members in a class show \( X \) in the input data, then the child generalizes to the entire class. Otherwise, \( X \) is lexicalized for those specific members. Generalization only occurs when the number of exceptions to a class with \( N \) members that could follow rule \( R \) is less than \( N/\ln(N) \). A true case of overgeneralization and retreat, for example, can be found in learning double-object datives (Yang 2016). In the present case, there are not enough verbs such as *begin*, as I have shown, to meet the threshold; therefore, the child does not generalize. In fact, the analysis proposed here can also be extended to claim that we would never expect to see a language where raising predicates would be overgeneralized. In addition, the child also only uses unambiguous cues—i.e., non referential subjects—to identify raising verbs.

4. The Acquisition of Causatives

It has been observed in the literature that children make errors involving causatives (Bowerman 1982; Pinker 1989). The errors involve the learner extending a causative form to verbs that could potentially be used as lexical causatives, but are not. For instance, in English it is possible to say *I killed John* to mean I did something that caused John to die, but it is ungrammatical to say *I died John*, although many languages do not distinguish between *kill* and *die* in this way. Some examples of errors from child speech are provided below:

(20) General causative errors (from Bowerman 1982):
   a. He’s gonna **die** you David.
   b. Kendall **fall** that toy.
   c. You **ached** me.
   d. Water **bloomed** these flowers.

The examples provided above illustrate the overgeneralization of the causative form to verbs that do not typically causativize; i.e., verbs like *die* and *fall* are used with an agent subject and an object, and the agent performs an action on the object. This may also result in a final state of the object if the verb is used like a change of state verb. As we saw in the previous chapter with the acquisition of control and raising verbs, I address the question of the generalizability of the causative alternation rule from the input. Adopting Yang’s (2005, 2016) Sufficiency Principle, I show here that children generalize rules in their grammar when there is sufficient evidence in the input, and they retreat from their generalization when there is insufficient evidence in the primary linguistic data.

4.1. Background

This section provides a background on the kind of causative errors observed in children’s grammar, and previous approaches that have been proposed to account for these errors. I discuss two lines of work: one that appeals to statistical preemption and entrenchment as learning mechanisms (e.g. Ambridge, Pine,
Rowland, and Young 2008; Bowerman and Croft 2008), and the other that proposes linking rules between verb semantics and their structure (e.g. Pinker 1989). We see that neither line of work satisfactorily captures the facts of the causative overgeneralization.

4.1.1. Causative Errors

In order to discuss previous analyzes, I first present the nature of the problem in more detail. In this section, I describe the systematic rule that is overgeneralized to verbs that do not conform to the rule in adult English.

The causative errors observed by Bowerman (1982) occur with verbs belonging to a wide range of semantic classes. The verbs and their association with a narrow semantic class, as described by Pinker (1989), is provided below. The following table of overgeneralized verbs is from Pinker (1989), who summarizes the errors made by Bowerman’s children.

<table>
<thead>
<tr>
<th>Subclass</th>
<th>Verbs</th>
<th># of Sentences</th>
</tr>
</thead>
<tbody>
<tr>
<td>Directed motion</td>
<td>come, go, fall, rise, drop</td>
<td>30 (28%)</td>
</tr>
<tr>
<td>Going out of existence</td>
<td>die, disappear, vanish</td>
<td>12 (11%)</td>
</tr>
<tr>
<td>Being/staying</td>
<td>stay, be, spell, sound, wait</td>
<td>16 (15%)</td>
</tr>
<tr>
<td>Possession</td>
<td>have, take</td>
<td>13 (12%)</td>
</tr>
<tr>
<td>Psychological</td>
<td>remember, watch, guess, wish, feel, ache, learn</td>
<td>12 (11%)</td>
</tr>
<tr>
<td>Involuntary emission</td>
<td>sweat, blood</td>
<td>3 (3%)</td>
</tr>
<tr>
<td>Internally caused state change</td>
<td>bloom</td>
<td>1 (1%)</td>
</tr>
<tr>
<td>Semivoluntary expression of emotion</td>
<td>laugh, cry, giggle</td>
<td>5 (5%)</td>
</tr>
<tr>
<td>Voluntary action</td>
<td>eat, drink, sing, talk, swim, climb</td>
<td>14 (13%)</td>
</tr>
</tbody>
</table>

Table 9 provides an overview of the kind of verbs that children assume can be causativized.\(^\text{16}\) As can be seen from above, these verbs belong to a variety of semantic classes, but a majority of these verbs are unaccusative verbs. I return to this point in later sections.

4.1.2. Experimental Evidence for the Productivity of the Causative Alternation

Thus far, I have described the causative errors as noted in dairy studies (e.g. Bowerman 1982; Lord 1979); however, it is also important to discuss the productive nature of the causative rule overall. This section

\(^{16}\)The work on acquisition done to date primarily refers to these original set of errors (e.g. Ambridge, Pine, Rowland, and Young 2008. However, the production data from these children are not available in the public domain. As we see later on in the chapter, I will propose an analysis that is generally applicable, but I present more novel data extracted from the CHILDES database to do so.
presents experimental results that find that intransitive (unaccusative) verbs are productively causativized when they involve external causation. This particular aspect is important as most errors noted are of this type, where there is physical external causation involved even with verbs that do not linguistically encode it, such as *fall* and *disappear*. Even though not all verbs that involve direct external causation in situational contexts are used with the lexical causative, we find that the rule to causativize novel verbs of this type is productive in the adult grammar. The productivity of the causative alternation indicates that a strict lexicalist hypothesis is unable to capture the extension of the rule to novel verbs.

Maratsos, Gudeman, Gerard-Ngo, and DeHart (1987) examine the productivity of the causative alternation by investigating whether novel verbs heard only in the intransitive frame are used as transitives spontaneously in an experimental setting. They tested the productivity of the causative alternation on children aged 4;6 – 6;2 years using the novel verb *fud*. This verb in the causative refers to a dough-like substance converting into strands by the means of a machine. In the intransitive, it refers to a dough or clay-like state. In the experiment, a total of six sessions with story-telling and demonstration tasks for spontaneous production were used overall, in addition to a sentence completion task. 40 children in total, who were assigned to four groups, participated in the experiment. Group I heard *fud* only as a transitive (control group), while group II heard *fud* only intransitively. Those in group III were exposed to sentences that were intransitive with a locative or benefactive, and Group IV also heard *fud* as an intransitive, but the children here were not encouraged to use the verb overtly in any way; they were simply told that they were going to learn about *fudding*. *Fud* was never used as a periphrastic causative.

The results of the study found that children used *fud* as a verb ranging from 8 times by one child and 107 times by another. If a verb was used with an agent, it was counted as transitive even when the object was omitted. Although the results varied between groups, preference for the use of the causative form was found overall. Group I, the control group, produced transitive causative sentences 98 and 97% of the time in story and demonstration tasks when they heard the novel verb used in the transitive causative frame. Those in group II produced the causative form 23% of time in spontaneous production and 37% of the time in the sentence completion task even when they did not hear the novel verb used in a transitive frame. Group III produced *fud* 27% and 23% of the time in spontaneous speech and the sentence completion task respectively, and Group IV did so 21% and 30% of the time. Even when the children did not hear the novel verb used in a causative frame, they produced the verb transitively 26% of the time overall, indicating productivity of the causative alternation and supporting Bowerman’s (1974) claim that children produce these causative errors in a systematic way.

In addition, Gropen, Pinker, Hollander, and Goldberg (1991) also find evidence for the productivity of the causative. Children causativize intransitive verbs when the action depicts a direct causative relationship. Altogether, we have seen throughout this section that children and adults both readily and productively causativize verbs denoting direct external causation from their intransitive frame. The reverse is not found. Thus, I assume that children also causativize from an intransitive frame.

Throughout this section, we have seen evidence for the productivity of the causative alternation. We bear this in mind as a theory that assumes a strict conservative form of lexical learning would not predict that these forms should occur productively in the first place. The results also indicated that participants were almost always unwilling to use a novel verb that they had heard in a transitive causative frame as an unaccusative without positive evidence indicating that the verb could occur as an intransitive. In the following section, I discuss lexical semantic and usage based approaches that provide an account of the productive and unproductive aspects of the causative alternation rule.
4.2. Lexical Semantic and Usage-based Approaches

In the following subsections, I describe two main approaches to the acquisition of causatives. One line of work argues for innate semantic classes that guide the learner to the adult grammar (Pinker 1989), and the other approaches invoke preemption and entrenchment to account for the overgeneralization facts. Preemption accounts claim that the causative errors can be overridden when the child learns another causative form of the same verb. These are cases where the causative form of the inchoative verb appear to be suppletive such as *kill* and *die*. I show that preemption cannot adequately result in retreat from overgeneralization, and moreover, there appears to be no effect of preemption on retreat from causative errors overall (Ambridge 2008; Bowerman and Croft 2008). Additionally, I argue against an entrenchment account, which claims that if a verb is heard in an intransitive frame enough times, the learner will assume that it can only occur as an intransitive. I provide evidence against this approach by showing that verb frequency alone cannot account for the overgeneralization and the retreat from overgeneralization.

4.2.1. Approaches Deriving Argument Structure Learning from Verb Semantics

This section describes an analysis of the acquisition of causatives (Pinker 1989) that proposes linking rules between the semantic structures of the verb. Under this analysis, the acquisition of the semantic properties of the verbs result from the acquisition of the semantic class they are associated with.

The causative alternation has often been associated with particular sub-classes of verbs grouped by their primitive meaning such as manner of motion (Levin 1993; Levin and Rappaport Hovav 1995; i.a.). Verb classes with certain semantic properties alternate, while others do not. Pinker (1989) argues that these semantic classes are innately available to the learner. The learner then applies linking rules from the semantic representation of the verb to the syntactic structure. Thus, the linking rules proposed by Pinker require the alternation to apply to the semantics of the verb, and not to its structure. As the learner acquires these semantic classes and associates the correct semantic representation to the verbs within these classes, they will arrive at the adult grammar.

The semantic properties of verb classes are delineated as broad range and narrow range rules. Broad range rules are properties that work top down within a class, while narrow range rules work bottom up. Pinker proposes these rules to account for the verbs that fall within a large verb class with certain semantic properties, but still do not display some of the properties typical for members of that class. This notion can be explained further by considering the case of causatives. Pinker claims that verbs that undergo a change of state, such as *melt*, *open*, etc., should alternate as change of state verbs typically display this property. However not all verbs, like *disappear*, which denote a change of state do. Therefore, for this class, the broad range rule of change of state is a necessary, but not a sufficient condition for the alternation. Verbs are also associated with narrow range rules that dictate the conditions on the causative alternation. These conditions are acquired later on.

Pinker claims that overgeneralization errors occur due to the application of broad-range rules, or the systematic misconceptions about meanings of particular verbs (Pinker 1989:292). Children erroneously causativize verbs like *be* and *come* because the discourse context calls for a lexical causative that is not available to them. According to Pinker, this situation never arises for adults as there is always a high frequency causative available to them. Pinker also cites Clark (1987) in saying that children stretch the boundaries of their knowledge as they have pervasive lexical gaps. They lack the adult means to communicate. For instance, they might not have the causative forms like *keep* and *bring* properly analyzed early on, which is why they make errors with the intransitive forms. Pinker suggests that as transitives are re-mastered, the causative errors decline. The argument consists of three parts: i) children’s use of argument structure alternation are always semantically conditioned, ii) children’s overgeneralizations are generally due to the use of property-predicting (broad-range) rules, and iii) children’s overgeneralizations are due to
incorrect verb meanings. I argue that these reasons are inadequate in accounting for the patterns we find in child data.

As stated earlier, what consists of a relevant semantic class, under this approach, is innately present in the child’s language learning mechanism. Children are said to be constrained from the beginning so that the causative errors they make do not carry any significance. They are simply the result of not perfecting the narrow range rules. Under this account, the problem of retreating from a super set hypothesis does not exist as children do not initially overgeneralize. They will always arrive at the adult grammar once they have learned the relevant conditions on each semantic verb class. In the proposed dissertation, I show that the errors are a result of a generalizable rule at earlier stages of the acquisition process.

In addition, since children are said to arrive at the correct semantic classes later on, initially, they are claimed to systematically learn verb meanings incorrectly. For instance, when children produce *go me to the bathroom, they mean take me to the bathroom. Therefore, when children learn take, they will replace the erroneous form of go, and the causative errors will cease to occur. This statistical preemption approach also predicts that verbs that are more frequent would be learned sooner than more infrequent ones. Verbs that occur more frequently are expected to be learned earlier, and hence, errors with relatively frequent verbs are expected to wane sooner as well. This expected difference between verbs of varying frequency is not found. Children produce causative errors with verbs as frequent as go, which is said to be used in place of take, another frequent verb. These verbs are more frequent than another possible suppletive pair die and kill, and yet, children produce these errors around the same time. I return to the preemption approach is more detail in Section 4.2.3. For now, I simply note that this approach is also that of indirect negative evidence, even though Pinker (1989) denies that fact. Such an approach crucially requires that the learner stop using the causative form of pure intransitive verbs when another causative verb with a similar meaning can be used. They stop producing the ungrammatical causative form because it has not been encountered in the input.17

Additionally, in the same vein as Pinker (1989), Ambridge et al. (2011) also appeal to the verb semantics to feed information regarding verb argument structure. Pye, Loeb, and Pao (1996), among others, discuss briefly how the semantics leading to the assumption of a particular verb structure is problematic crosslinguistically. The analysis I propose does not assume that the argument structure is derived from the semantics. This is also a crucial difference between my approach and Pinker’s. I assume and propose that the semantics can be used to group verbs together as a class, but the syntactic properties of the individual verbs allow children to form generalizations across the entire class if there is sufficient evidence to do so. This sufficient evidence is defined by the Sufficiency Principle. Before moving on to my analysis, let us first discuss other approaches to the problem.

4.2.2. Usage-Based Approaches

In this section, I describe approaches that invoke the use of indirect negative evidence in order to account for the retreat from overgeneralization (Brooks and Tomasello 1999a; Bowerman and Croft 2008). Unlike models that assume linking rules for the property of verbs, Bowerman and Croft (2008) acknowledge that children’s causative errors are productive in their model. The causative errors are then resolved over time when a more prominent form of the verb in the input replaces the child’s rules for overgeneralization. This

17Pinker (1989) argues that a preemption analysis under his account is not that of indirect negative evidence. The claim is that children simply never produce ungrammatical causatives of intransitive verbs because there is another causative verb with a similar meaning that can be used. However, unless one claims that children deem the causatives of pure intransitives as ungrammatical because they have never occurred in the input, which is an indirect negative evidence approach, the argument is only for that of production and not competence. If children were merely not producing ungrammatical forms because of the presence of another verb, then we would expect that they grow into adults who never produce causatives like *go me to the bathroom, but are happy to deem it grammatical.
model relies on one crucial aspect: that there is another more pervasive form of a verb in the input that can preempt the child’s form.

Under this approach, there are two types of verbs that are overgeneralized in learning causatives: verbs that have a phonological distinct, i.e., suppletive lexical causative form, (e.g. kill and die), and verbs that do not, (e.g., disappear). For verbs that do not have a suppletive causative form, the make causative is said to preempt the child’s rule; i.e., make disappear preempts the overgeneralized form of disappear X, although this is said to be less powerful than preemption via lexical causatives. In addition, repeated exposure to the intransitive form of verbs like disappear, result in the entrenchment of this frame, and children are said to become less likely to causativize these verbs.

Although this approach discusses the mechanisms through which children can retreat from positing an incorrect causative form to verbs that do not allow them, the analysis does not discuss the reason for this overgeneralization. Why do children propose a rule for verbs that do not have a causative form in the first place? A linking rules approach addresses this problem by claiming that younger children have not fully mastered the specific properties of each semantic class. In Section 4.3, I argue that children overgeneralize when there is sufficient positive evidence to form a productive rule that can apply to verbs for which they have not heard the causative form.

Another line of work proposes the entrenchment of verb semantics, which allows children to form verb classes (Alishahi and Stevenson 2008; Ambridge 2013; Ambridge and Lieven 2011; Ambridge, Pine, Rowland, Jones, and Clark 2009; Ambridge, Pine, Rowland, and Young 2008). For instance, Ambridge et al. (2008, 2009) argue that the possible argument structures for each verb are stored each time they occur, and the more times the verb occurs, the higher the probability that the verb will only be used in the argument structure frames in which it has been encountered. Thus, when the child hears a verb like fall only occur as an intransitive, over time, the probability of the verb occurring as a transitive decreases until the learner assumes it can only occur as an intransitive. Furthermore, verb semantics also play a role in addition to entrenchment under this analysis, and the process of entrenchment is claimed to include entrenchment of semantic classes. The idea behind using entrenchment as a learning mechanism for the causatives problem is that children are said to learn the semantics of verbs through the environments they are found in. In other words, the verbs are entrenched in their meaning by their environment. Similarly, when a verb is only heard as an intransitive in the input, over time, the verb becomes entrenched as an intransitive. The notion of entrenchment, hence, involves the use of indirect negative evidence, as the absence of one verb form is taken as evidence for its non-existence.

As stated earlier, the frequency of a verb plays a key role under an entrenchment approach. Ambridge et al. (2008, 2009, 2011) argue that verbs that are more frequent in the input are rated as less acceptable than less frequent verbs in the same class. For instance, in testing adults, Ambridge et al (2011) find a difference in the acceptability between fall and tumble as causatives. Participants were found to rate the more frequent verb fall a 1.46 on a 7 point Likert scale, and the less frequent verb tumble a 2.68 out of 7. I note here that the aforementioned results only suggest a possible effect of verb frequency, and not a robust distinction in the structural properties of these verbs. However, in order to firmly confirm that adults at least show effects of entrenchment, one needs to rule out whether these effects stem from other semantic properties of the verb. I address this question in the proposed dissertation.

Furthermore, Ambridge et al. (2008) argue that other situational factors play a role; 5 and 6 year old participants rate the causative form of the novel verb meaning laugh significantly lower than its intransitive form ($p = 0.001$); however, they do not rate the causative forms of novel verbs of disappearing and falling differently from their intransitive forms ($p = 0.1$ and $p = 0.9$ respectively). 9 an 10 year old children always significantly preferred the grammatical forms over the ungrammatical forms. They argue that these results indicate that the level of direct external causation determines the level of acceptability of causatives. In contrast, I note that in comparing verbs like laugh to verbs like disappear, there are other
differences between them besides external causation; verbs like laugh in the intransitive frame are agentive whereas verbs like disappear are not. Ambridge et al. (2008) treat laugh in its intransitive form crucially as an inchoative on par with intransitive disappear (Ambridge et al. 2008:87, footnote 1). Moreover, the willingness of 5 and 6 year olds to accept the causative form of disappear and fall type verbs is attributed to the development of semantic classes with age. However, crucially, these results show that children differentiate between the semantics of laugh, an unergative verb, and disappear and fall, two unaccusative verbs. I return to these points in later sections.

In this section, we saw the way in which indirect negative evidence has been proposed to account for retreat from overgeneralization. The following sections provide arguments against the use of indirect negative evidence to account for this problem by showing that these approaches do not address the productivity of the causative errors, nor are they able to adequately account for the retreat from overgeneralization.

4.2.3. Evaluating Preemption and Entrenchment

A statistical preemption account of pairs like kill and die still leaves open the question of why children make causative errors at all. What is the rule that causes children to produce the causative form of die as opposed to entrenching it as an intransitive? In addition to leaving the root of the causative errors unaddressed, in this section, I show that an indirect negative evidence approach to retreating from the overgeneralization of causatives is not tenable.

As mentioned in the previous section, a crucial component of this model is the presence of a competing form of the same verb in the input that preempts the overgeneralized causative. For verbs that do not have a phonologically distinct lexical causative form in the input (like stay, but unlike remember/remind), the only other form in the input that can preempt causativized stay and disappear is the make-causative. However, the make-causative systematically carries a different meaning (Bowerman and Croft 2008), and is its own productive construction that appears to occur independently. Hence, the make-causative is said to be a weaker cue in the input than a phonologically distinct lexical causative form. Errors with verbs like disappear, in that case, are predicted to persist longer than those with verbs like die. This prediction is not borne out, as shown by Bowerman and Croft (2008) in examining the causative errors of two children C and E.

As graphs in Figures 6 and 7 show, there is no visible difference in the rate of abating errors between verbs that have a suppletive counterpart and verbs that do not for either child. These error rates are our first indication that preemption using causative verb counterparts of the overgeneralized verbs may not be the right mechanism through which children retreat from their overgeneralization. If that were the case, then we would expect a difference between disappear and die type verbs. Second, it is unclear whether make-causatives do preempt the causative forms of overgeneralized verbs at all. There is evidence form child data that children are aware of the make causative early on, even for verbs that they overgeneralize. The following examples of make causatives are found in child speech:

(21) Make causatives in child data:

a. someone made me go away (2;9, Ross, MacWhinney corpus)
b. I’m going to make it disappear (3;2, Ross, MacWhinney corpus)
c. Shoes may make you jump higher (3;9, Adam, Brown corpus)
d. you stand up to make it go fast (3;10, Adam, Brown corpus)
e. Mommy make it stay under dere (4;1, Adam, Brown corpus)
f. I make my icecream disappear with no holes in it (4;3, Adam, Brown corpus)
g. She’s gonna make it die (5;0, Christy, Bowerman 1982)
As one can see from the examples above, the verbs in (21) are exactly those verbs that children are said to make errors with. Moreover, the use of the make causative overlaps with the time at which we notice the overgeneralization of the causative rule, indicating that children are aware of this alternative construction at the time when the errors are produced. Some examples of the causative errors made by Adam (Brown corpus) and Ross (MacWhinney corpus) are shown in (22).

(22) Causative errors produced by Adam and Ross:
   a. ./32b.cha:*CHI: and my mommy might break this and fall this . (3;0, Ross, MacWhinney corpus)
   b. ./36a1.cha:*CHI: I want to disappear it . (3;3, Ross, MacWhinney corpus)
   c. ./adam34.cha:*CHI: gon(na) fall him to pieces . (3;7, Adam, Brown corpus)
   d. ./48b2.cha:*CHI: how did it disappear this air out_of here (4;2, Ross, MacWhinney corpus)
   e. ./adam51.cha:*CHI: how to go it ? (4;7, Adam, Brown corpus)

(22) shows that both Adam and Ross know the make causative construction when they produce the lexical causative errors. The make causative examples produced with verbs like go and disappear also illustrate that both children are aware of an alternative construction in place of a potential lexical causative form of these verbs. However, the make causative does not preempt the lexical causative in these cases. Furthermore, the make causative form does not preempt the lexical causative in verbs that allow for both in adult grammar; both of these forms for a single verb are clearly possible, and therefore, they likely exist independently of each other. Below are some verbs that allow both the make-causative and the lexical causative forms.

(23) Verbs that allow both lexical causative and make-causative forms:
   a. I made the ice melt / I melted the ice.
   b. I made the ship sink / I sank the ship.
   c. John made the house burn down / John burnt down the house.
The examples above show that the make causative and the lexical causative can coexist. Therefore, it is not obvious why the make causative would then preempt the hypothesized causative form of verbs. Since children are aware of the make-causative forms and use them frequently, a preemption account cannot say that children stop making causative errors by learning the make-causative for those verbs later on. Furthermore, Ammon (1980) discusses the meaning contrasts between lexical and make-causatives. Fodor (1970) argues that make causatives embed a syntactic structure whereas lexical causatives do not. Shibatani (1973) discusses the meaning contrasts in some detail; i.e., the directness and indirectness of causatives. Clark (1978) states that they are developed early and independently. Baron (1972) and Limber (1973) also find evidence for periphrastic causatives before the age of 3.

The alternative to preemption under these approaches is entrenchment (e.g. Brooks and Tomasello 1999). Brooks and Tomasello (1999) argue, for instance, that children are more likely to use an intransitive frame for novel verbs heard in an intransitive frame. Entrenchment of a form then predicts that a verb heard in an intransitive frame, such as die or disappear are unlikely to be used as transitives in the first place. We are then forced to dismiss the causative errors of children as insignificant yet again. As we have seen in the child data, these errors are produced frequently with a wide variety of verbs. Children are visibly aware of a pattern in their language, which they are exploiting. In dismissing this pattern, we would be overlooking the possibility that children are principally forming productive rules from the positive evidence available to them in the input.

In addition to the aspect of conservative learning implied by the entrenchment account, I find that the prediction of errors made by this approach is not borne out. An entrenchment approach, which claims that children cease to make causative errors once they’ve heard a verb used in an intransitive frame many times, predicts a difference in the production of errors between verbs of varying frequencies. The child is expected to retreat from using a pure unaccusative verb in a causative frame earlier if the verb occurs with a relatively high frequency in the input. This prediction can be tested by examining the causative errors made by the children in CHILDES. Ross from the MacWhinney corpus (MacWhinney 2000), for instance,
makes several causative errors. Some of these errors are presented below:

(24) ./36a1.cha:*CHI: maybe I can fall it down the stairs . (3;3)
(25) ./41a2.cha:*CHI: and are you going to stay me at my new school at Pittsburgh (3;5)
(26) ./46b1.cha:*CHI: to go it down my tummy . (3;11)

As the examples above illustrate, Ross makes causative errors with different kinds of unaccusative verbs. We find that these verbs vary in terms of their frequency. I searched through all the caretakers’ speech in CHILDES; i.e., the combined input data from all the corpora, and found the total number of times these verbs occurred in the input. Out of the 6 million words of combined data, disappear occurs 153 times overall. Stay occurs a total of 2,662 times, fall a total of 2,819 times, and go occurs 55,689 in all. However, in spite of the differences in their frequency, the errors we find for Ross all cluster together around the age 3-4, and there is no evidence that the child stops producing errors from these verbs purely on the basis of hearing them intransitively a number of times. If the entrenchment hypothesis were true, we would not expect children to be making errors with verbs like go that occur over fifty thousand times in the input data. If it was true that a verb needed to be heard that many times in order to learn its argument structure, we would expect children to be making causative errors with verbs like disappear, which occur a fraction of the time, well until their adult years. As we are aware, this is not the case.

A further argument that I will pursue in the dissertation is that of the rate of frequency of the causative form between those predicates that causativize and those that do not. I will examine the frequency rate of causative forms of verbs like bounce, which have a lexical causative, and verbs like disappear that do not. In comparing these rates, we will find whether the difference in the rate of frequencies between the causative forms of these verbs is adequate enough to tell their structural properties apart.

In the next section, I discuss an alternative learning mechanism to both preemption and entrenchment. I argue that children make generalizations of the properties of verbs from sufficient positive evidence in the input, and they retreat from these generalizations when there ceases to be sufficient positive evidence in the input.

4.3. Learning Causativization

The literature on child verb learning suggests that children make use of structural information along with situational cues. These verb learning approaches are argued to be relevant for learning causative verbs as well (Naigles 1990, 1996a; Naigles and Hoff-Ginsberg 1995; Pinker 1989). In this section, I describe how structural and situational cues aide the child in acquiring the different kinds of intransitive verbs. We delve into how the learner uses notions such as intentionality to distinguish between unaccusative and unergative verbs. Once the learner has identified the two types of unaccusatives, I show how they generalize the causative rule from the evidence available to them in the input. I also demonstrate how as the learner acquires more verbs, there ceases to be sufficient evidence for the causative alternation rule, and the learner no longer generalizes. Furthermore, I argue that the motivation behind subdividing verbs into smaller classes may arise from the need to form productive rules in language (cf. Yang 2016); i.e., the learner searches for subclasses of verbs to identify a class where the causative alternation rule is in fact generalizable.

4.3.1. Learning Verb Classes from Structural and Situational Cues

This section describes the situational concepts and structural information used by the learner in acquiring verb classes. I first discuss how unaccusative and unergative verbs are differentiated, as this distinction results in the overgeneralization of the causative rule. The adult grammar shows a productive causative
rule for some classes; e.g., the manner of motion class consisting of verbs like roll (see also Brooks and Tomasello 1999a), but not all kinds of verbs show this rule productively. For example, verbs of inherently directed motion do not generally display this property (e.g. rise). In showing how the learner acquires these subclasses where the causative alternation rule is productive, I address the situational and structural cues that they are attuned to. I primarily focus on causality and motion in this section.

Languages are known to exhibit two kinds of intransitive verbs (e.g. Perlmutter and Postal 1984): unergatives and unaccusatives. Unergative verbs introduce an external argument, and optionally allow certain kinds of objects, while unaccusative verbs do not introduce an external argument. Given these two types of verbs, the learner is faced with the task of distinguishing between the two classes of verbs, as a host of properties are associated with each type. Learning the two classes of verbs is also relevant to the acquisition of causatives as it is primarily the class of unaccusative verbs that show the property of the causative alternation; unergative verbs generally do not display this property. Consequently, the generalization of the causative rule that children make cannot stem from considering the entire class of unergative verbs as well. In order for the rule to become a candidate for generalizing, the learner must have identified the distinction between them. Below, I describe how children make this differentiation between unaccusative and unergative verbs.

I argue that children use intentionality as a differentiating factor between unaccusative and unergative verbs. Unergative verbs in their intransitive frame are known to typically show intentionality (e.g. Jamie ate), whereas unaccusative verbs in their intransitive frame lack intentionality (e.g. Jamie fell). An unergative verb like eat, thus, shows intention, whereas an unaccusative verb like fall does not. There is some evidence in the literature that children are attuned to notions like intentionality early on (e.g. Tomasello and Barton 1994; Woodward 1998). For instance, Woodward (1998) uses a visual habituation paradigm to show that children distinguish between animate and inanimate agents. In her studies, infants between the ages of 4 to 11 months were habituated to the motion of a hand grasping or a rod touching one of the two objects placed in front of them. In the testing phase, the infants were shown a new object grasping a different object. The results showed that infants in the hand condition, but not the rod condition looked longer at action when there was a new goal with an old path versus in trials that showed a new path with an old goal. These results indicate that infants as young as a few months old are able to encode the goal-oriented nature of actions. As intentionality as a concept is known to learners, I will use intentionality as a way of singling out unergative verbs from unaccusatives.

The proposed dissertation will explore more distinctions between the two types of intransitive verbs. For instance, it has also been argued that telicity sets apart unaccusative verbs from unergatives (Borer 1994; Grimshaw 1990; Levin and Hovav 1992; Tenny 1994; Tenny 1987; Van Hout 1996; i.a.). I will examine the role of telicity in the dissertation, and also consider the notion of agentivity as well, which often coincides with intentionality.

Now that we have discussed how children learn the larger set of unaccusative verbs, we can discuss how children learn finer distinctions within this large class. We recall from earlier sections that children and adults both productively use the causative rule when there is direct external causation (e.g. Maratsos et al. 1987), and moreover, that manner of motion verbs show this property as well (e.g. Brooks and Tomasello 1999). Here I present findings that argue that children are attuned to notions such as causality. I also provide an overview of how structural information can be used to identify motion verbs in the input.

It has been shown that children can identify the causality component of a verb from multiple syntactic frames (Landau and Gleitman 1985; Naigles 1996b; Naigles and Hoff-Ginsberg 1995). Naigles (1996b) shows that learners cue into the meaning of a verb, not only from causative frames, but other frames that may denote a causative meaning. It has also been argued in this line of work that children are also able to differentiate between contact verbs like touch and verbs that reflect causation in the world like break, suggesting that the notion of causality is truly evident. These findings are relevant to the work presented
here, as the learner arrives at a grammar that singles out verbs that indicate direct external causation.

Structural information also comes into play in learning causative verbs. For some abstract verbs, if a causative form exists in the language, it must be learned from the linguistic input. This fact is clear from cross-linguistic differences in which a verb like *arrossire* ‘blush’ has been argued to have a direct causative form in Italian (e.g. Levin and Hovav 1992), but not in English where sentences like "the sun blushed my cheeks" are ungrammatical. Similarly, the Hindi verb *khilaanaa* ‘to make bloom’ or ‘to make blossom’ has a lexical causative form, which is a pure intransitive in English. This verb in English is said to be internally caused, and therefore, does not undergo external causation (e.g. Pinker 1989), but this claim does not hold for this verb in Hindi. However, as discussed earlier, the possibility of direct causation needn’t be learned from the input for all verbs, especially not verbs that involve physical contact such as *fold*. In these cases, there is situational evidence for a verb to be learned as involving direct causation, but we cannot do away with the structural information that supplements the learner’s knowledge for more abstract verbs denoting a direct causative relationship. Thus, both situational and linguistic cues are indispensible to the learner in acquiring the finer primitive meanings of unaccusative verbs.

The importance of structural cues is also evident in learning motion verbs. There are structural correspondences in the syntax that indicate motion in the meaning of a verb. For instance, verbs followed by locative prepositions often indicate a motion verb like *roll* (Fisher, Gleitman, and Gleitman 1991; Talmy 1975). This structural cue is available for all of the inherently-directed motion verbs and manner of motion verbs listed in Levin (1993). Thus, we have seen so far how the combination of structural and semantic cues allows the learner to distinguish between unaccusative and unergative verbs, externally caused verbs and internally caused verbs, and motion verbs from the other unaccusative verbs.

In sum, studies on children’s knowledge of linguistic and situational cues indicate that children are attuned to concepts such as intentionality and causality as early as 12 months (Carpenter, Akhtar, and Tomasello 1998; Woodward 1998; Woodward, Sommerville, and Guajardo 2001). Leaving aside the question of whether children are innately endowed with the ability to identify cues such as causality and intentionality, we can at least use the findings that children are aware of these concepts early on. Now that we have seen which structural and semantic cues are relevant to the learner in acquiring the semantic and syntactic properties of verbs, we can move on to the question of how children overgeneralize the causative alternation rule from positive evidence in the input, and how they eventually retreat from this overgeneralization.

### 4.3.2. Corpus Data

According to the Sufficiency Principle, the causative errors only arise when there is enough evidence in the input to generalize this rule over other members in a given class. Although we cannot claim with certainty whether a semantic class for a particular group of unintentional intransitive verbs has been formed, we can investigate the causative errors made by children to determine whether verbs that do not have a causative frame are treated in the same vein as verbs that do causativize. I examined Adam (Brown 1973) and Ross (MacWhinney 2000) as two case studies of children who go through a stage of overgeneralizing the causative alternation. These two children are good candidates to test the claims made so far as there is more data available for them than most individual children in CHILDES, and both of these children make causative errors.

The errors noted for Adam often involve verbs of inherently directed motion such as *come* and *go*, among others. Examples of the errors produced can be found below:

(27) a. ./adam24.cha:*CHI: don’t fall my head . (3;2)
    b. ./adam34.cha:*CHI: gon(na) fall him to pieces . (3;7)
    c. ./adam51.cha:*CHI: how to go it ? (4;7)
Adam makes these causative errors up to age 4;7; however, since the data for Adam ends at age 5;2, we cannot say for sure when these errors stopped occurring. The errors we do find indicate that the stage of overgeneralization lasts for as long as Adam’s corpus.

To establish whether the causative errors arose in the input from sufficient positive evidence, I checked Adam’s production data for each verb used until the first unambiguous error was produced at age 3;2. Up to age 3;2, Adam produces a total of 208 verbs in CHILDES.\textsuperscript{18} Out of these 208 verbs, 110 of them occur as a plain intransitive. From these verbs, using intentionality as a guideline for distinguishing most unergative verbs from unaccusative verbs, we were left with 51 verbs that lacked intentionality in an intransitive frame. These verbs included two verbs, laugh and cry, which are generally classified as unergatives in the adult grammar (Perlmutter and Postal 1984). 59 of the plain intransitive verbs showed intentionality, and thus, were removed from further consideration. The summary of Adam’s verbs can be found in the Table 10:

<table>
<thead>
<tr>
<th>Verb Type</th>
<th>Number of Verbs</th>
<th>% of Total Verbs</th>
</tr>
</thead>
<tbody>
<tr>
<td>transitive</td>
<td>98</td>
<td>47.4%</td>
</tr>
<tr>
<td>intentional intransitive</td>
<td>59</td>
<td>28.2%</td>
</tr>
<tr>
<td>unintentional intransitive</td>
<td>51</td>
<td>24.4%</td>
</tr>
</tbody>
</table>

The child’s production data within a single corpus can be used to determine whether the child knows a verb at all, but not to gauge whether the child can use the verb in all possible frames. I determined this here by checking to see whether a verb had been used at all, regardless of the verb frame in which it was used. To check whether these verbs occur in the input with a causative form, however, we cannot rely on any single caretaker’s production for this information. Words in the input follow a Zipfian distribution; i.e., many verbs only occur a few times, or even just once in the input data. Therefore, it is unexpected that we would find each verb occurring in all possible syntactic structures in a single caretaker’s datafile. In contrast, examining the caretaker’s production data for all of CHILDES would be able to provide us with a reasonable guess as to whether a verb occurs as a causative in the linguistic input. Combining all the corpora from CHILDES, I checked to see whether the above verbs used by Adam occurred as a causative in the input in CHILDES.

Two verbs from the 51 unintentional plain intransitives, fold and print, had to be excluded from the analysis as they did not occur in an inchoative frame; i.e., they only occurred as infinitives.\textsuperscript{19} Out of the remaining 49 verbs, 12 of them did not occur with a causative frame in the input data in CHILDES. Many of these verbs like fall do not have a causative form in the adult grammar. Following the sufficiency principle, a class with 49 members requires at least 36 verbs to show a property in order for the property to be generalizable. Here, 37 verbs show the causative alternation, and hence, the rule is generalizable to the other members of the class, and Adam makes causative errors.

I note here that we would not expect Adam to generalize the causative alternation if all intransitive verbs were considered. In total, I found that Adam used 59 verbs that I classified as intentional intransitives. Out of these verbs, only 11 of them causativize in the adult grammar. Much fewer occur as causatives in CHILDES.\textsuperscript{20} As only a fraction of these verbs have a causative form, it would be unexpected that the child

\textsuperscript{18}A complete list of Adam’s verbs can be found in the appendix.
\textsuperscript{19}Note that both of these verbs also occurred in the causative frame in the input, and including them in the calculation would add two more verbs that follow the rule.
\textsuperscript{20}I will report the exact number of intentional intransitive verbs that occur in CHILDES in my dissertation.
would generalize the causative alternation rule if they were taking into account the entire set of intransitive verbs. The total number falls well below 50%, and most models would not make predictions for the learner to generalize so aggressively. I noted earlier that children are aware of intentionality early on (Woodward 1998), and therefore, we can assume that the learner is sensitive to a distinction along these lines.

Another case study of the causative overgeneralization was obtained from Ross’s data in the Macwhinney corpus. Like Adam, Ross also produced causative errors around the ages of 3-4 years, as shown in (28).

(28)  a. ./41a2.cha:*CHI: and are you going to stay me at my new school at Pittsburgh
    b. ./32b.cha:*CHI: and my mommy might break this and fall this .
    c. ./36a1.cha:*CHI: I want to disappear it .
    d. ./48b2.cha:*CHI: how did it disappear this air out of here
    e. ./46b1.cha:*CHI: to go it down my tummy .

The last error we see for Ross is around age 4;1. The errors here are clustered around the ages of 3 and 4, and hence, we can check to see if there was sufficient evidence in the input for these errors around these ages, and whether there ceased to be sufficient input in the later years. This can be achieved by looking through the child’s production data.

Similar to what was done for Adam, we can go through Ross’s data to find the list of verbs that he knew up to the time the first error was produced. For Ross, I obtained a total of 121 verbs.21 Out of 121, 66 verbs occur as plain intransitives in CHILDES. 42 of these intransitives showed intentionality. The remaining 24 verbs were intransitives lacking intentionality, which also included cry, an unergative verb. The different verb types are summarized in Table 11. 18 of the 24 verbs occurred with a causative form in the input in CHILDES. A class with 24 verbs requires 16 for the rule to be generalizable, and thus, the causative rule is overgeneralized to the other verbs.

<table>
<thead>
<tr>
<th>Verb Type</th>
<th>Number of Verbs</th>
<th>% of Total Verbs</th>
</tr>
</thead>
<tbody>
<tr>
<td>transitive</td>
<td>55</td>
<td>45.5%</td>
</tr>
<tr>
<td>intentional intransitive</td>
<td>42</td>
<td>34.7%</td>
</tr>
<tr>
<td>unintentional intransitive</td>
<td>24</td>
<td>19.8%</td>
</tr>
</tbody>
</table>

Additionally, it is also clear that Ross would have to divide the intransitive verbs along the lines of intentionality. Only 11 of the 42 verbs used by Ross can be causativized in the adult grammar. If the learner were to not categorize the verb classes this way, we would not expect any errors of overgeneralization. Adding the 11 intentional intransitives that causativize, there would only be 29 out of 66 intransitives in all that follow the causative alternation rule, which is well below 50%. Thus, the overgeneralization errors are crucially not unexpected under the Sufficiency Principle if the distinction based on intentionality was not made. It would be unexpected under any model of generalization that requires a majority to follow the rule.

Now that we have seen how overgeneralization occurs, we can discuss how children retreat from their overarching hypothesis. I claim here that the errors cease to occur when there is insufficient positive evidence in the input. This claim can be tested by examining corpus data as well. To find evidence for the unproductivity of the rule in later stages of acquisition, we must estimate the growing vocabulary of the learner. I compiled a list of all unintentional intransitive verbs from Levin (1993). I then found

21The complete list of Ross’s verbs can be found in the appendix.
the frequencies for these verbs in CELEX, and found the verb with the lowest frequency that occurred in CHILDES. This way, we can estimate the number of verbs the child comes to know later on. The verb with the lowest frequency that occurred in CHILDES is *germinate*, which has a frequency of 1 per million. Hence, I only considered unintentional intransitive verbs that occur with a frequency of once per million or higher, which resulted in a total of 261 verbs. Out of the 261 verbs, 65 only occur as intransitives; i.e., only 196 of the verbs have a causative form. According to the Sufficiency Principle, a class with 261 members requires at least \( N - N/\ln(N) = 214 \) verbs to follow the rule. 196 is insufficient evidence for the learner to generalize, and therefore, they cease to apply the rule to verbs for which they have not encountered the causative form. A general summary of the entire process can be seen in Figure 8. Figure 9 summarizes the acquisition of causatives under the current learning model.

**Figure 8:** Summary of the learning mechanism employed by children. Rules are determined based on sufficient positive evidence in the input as ascertained by the Sufficiency Principle. If the rule is unproductive, the learner seeks subclasses where a productive rule may be found.

I note here that learning verb properties cannot stop there. For instance, Maratsos et al. (1987) provide evidence that both adults and children use novel verbs that indicate external causation in a causative frame. These results show that the grammar does have productive rules for causativization. The approach I have taken here allows us to address how children end up with a productive rule for some verb classes, but not for all intransitive verbs overall. Recall that the goal of the learner is to find rules and patterns within their language to facilitate mastery of the grammar. Once the learner reaches the stage where the rule for forming causatives is not generalizable, they are motivated to look for further subclasses where the rule might in fact be productive. Two subclasses that are known to allow the causative alternation productively
are the manner of motion verb class and verbs that indicate external causation. I claim that children then learn these subclasses when the rule is not generalizable to the larger set of unintentional intransitive verbs.\textsuperscript{22}

I have shown so far how the evidence available in the input influences the learner’s decision to generalize a rule. In future work, I will consider the division of verb classes in more detail. For instance, there were a few unergative verbs such as \textit{cry} and \textit{laugh} used by Ross and Adam that lacked intentionality. I will address these verbs in the proposed dissertation to show how they can eventually be learned as unergatives. In doing so, I will also discuss the division of verb classes more generally, especially the division of verbs into unintentional and intentional intransitives.

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{figure9.png}
\caption{Summary of how verb properties are learned. Children first determine whether a given intransitive verb shows intentionality. Then, for each of those verbs, it is determined whether there is sufficient positive evidence to generalize the rule following the Sufficiency Principle. The causative alternation rule is generalizable when there is sufficient positive evidence, and it is not generalizable when there is insufficient evidence.}
\end{figure}

\textsuperscript{22}The same reasoning does not stop the learner from forming a productive subclass within the intentional intransitives. The intentional intransitive verbs that undergo the alternation are those like \textit{walk} or \textit{gallop} in uses like \textit{I walked the dog} or \textit{I galloped the horse}. These uses are specific in that they involve direct external causation on the object doing the action, and these verbs of motion may form a class of their own.
The analysis presented here is applicable to all the causative errors seen in child data. The overgeneralization stems from sufficient evidence to form a rule that can be extended to other members of a particular class. Children learn the semantic meanings of the verbs from situational and structural cues. The overgeneralization of the causative rule can happen at any point in the verb learning process. When the learner has acquired more verbs, there ceases to be sufficient positive evidence in the input to generalize the rule. Furthermore, it is the unproductivity of the rule that guides the learning of finer semantic class distinctions that we see in the adult grammar.

4.4. Testing the Sufficiency Principle

Throughout this work, I have invoked the Sufficiency Principle (Yang 2016) to provide a formal threshold for the learner to assume when a given rule is productive or not. When the positive evidence in favor of a rule exceeds $N/\ln N$ items for a total of $N$ members in any class, the learner is predicted to generalize the rule to the items in the class for which the learner has not seen positive evidence. As the Sufficiency Principle features centrally in the dissertation, I will empirically test the predictions it makes. Here, I present the proposed experiment with results from a pilot study.

Let us first discuss previous studies on how children make generalizations overall before diving into the details of the current experiment. Although these studies make predictions distinct from the Sufficiency Principle, they also focus on how children learn rules in their language. Work on regularization in child language acquisition has found that children regularize forms in their own production even when there are inconsistencies in the primary linguistic input (Aslin and Newport 2012; Austin 2010; Hudson-Kam and Newport 2005, 2009). For instance, when a particular nominal is used with a dominant marker between 40-67% of the time, but not 33% of the time, children will regularize the dominant marker to produce it over 80% of the time in their own usage (Austin 2010; Schuler et al. 2017). This line of research suggests that regularization at the word level can occur even when the dominant marker only occurs 40% of the time. At first glance, these results appear to violate the sufficiency principle (Yang 2016); however, it should be noted that the sufficiency principle crucially refers to generalization across types, and not regularization within a particular form, which is what the reported studies were testing.

Another relevant line of work that has empirically investigated children learning the causative alternation is that testing the predictions of entrenchment. When investigating the acquisition of causatives, Ambridge, Pine, Rowland, Jones, and Clark (2009) and Ambridge, Pine, Rowland, and Young (2008) argue that the absence of a causative form for a given verb serves as evidence against a causative form for the verb altogether. In other words, over time, if the learner does not hear a causative form for a verb, they assume that it does not exist. Under such a model of entrenchment, the higher the verb frequency, the more unexpected it is for the learner to overgeneralize a causative form for that verb given that they haven’t heard one. In this study, I will be able to test entrenchment effects directly as well.

The Sufficiency Principle predicts that for a class with 10 members, at least 6 of the 10 must follow a rule in order for that rule to be generalizable ($N - N/\ln(N) = 5.7$). If 6 or more of the members show positive evidence of following the rule, then the learner may generalize the rule to the other 4. 5 or fewer members does not suffice. In order to test the Sufficiency Principle, I designed an experiment using an artificial language with 10 verbs in two conditions presented in a between-group design. One condition consists of 5 out of the 10 verbs with a causative form, while the other showed 7 out of 10 verbs with a causative form. Participants exposed to the 7 out of 10 condition are expected to overgeneralize, whereas participants in the 5 out of 10 condition should not.

The experiment proposed here is also in a position to test the predictions of an entrenchment-based view of language acquisition. The verbs in the experiment follow a Zipfian distribution, which means that the frequency of the verbs vary. When a higher frequency verb occurs without a causative form, we can
see whether subjects treat it differently from a verb that lacks a causative form and occurs with a lower frequency.

I plan to run the experiment on both adults and children. Adult subjects are included to serve as control cases, but we bear in mind that the results for adults may be different from child results (Austin 2010; Schuler et al., to appear; i.a.).

4.4.1 Method for Proposed Experiment

4.4.1.1 Participants

Adult participants will be undergraduates at the University of Pennsylvania. Compensation for participation in the study will be in the form of course credit. There will be a total of 20 subjects per condition. A second experiment will also include children between the ages of 3 and 6, as those are the ages for which a majority of the causative errors are noted.

4.4.1.2 Stimuli

The artificial language consists of 1 novel subject, 5 novel objects, 10 novel verbs, and 1 novel causative morpheme -ka. The novel items conform to English phonotactics. These novel words occur in a total of 92 sentences in the corpus that participants were exposed to. There are two conditions, one where 7 out of the 10 verbs occur with a causative form, and the other where only 5 of them occur with a causative form. The frequency of these 92 items followed a Zipfian distribution for the verbs to imitate the frequency of words in natural language input, which is typically Zipfian. The first most frequent verb occurs 32 times, the second most frequent verb occurs 16 times, and the six least frequent verbs occur 4 times each. The other verbs occur 12 and 8 times. This distribution is shown in the table below:

Table 12: The distribution of verb frequency in the artificial language.

<table>
<thead>
<tr>
<th>Verb</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Verb 1</td>
<td>32</td>
</tr>
<tr>
<td>Verb 2</td>
<td>16</td>
</tr>
<tr>
<td>Verb 3</td>
<td>12</td>
</tr>
<tr>
<td>Verb 4</td>
<td>8</td>
</tr>
<tr>
<td>Verb 5 – 10</td>
<td>4</td>
</tr>
</tbody>
</table>

Each object occurs with 2 verbs. For the causative forms, the same subject Voz was used in all instances. The items used in the experiment can be found in Table 13. The word order of the language was verb-object-subject (VOS) to distinguish the syntax of this language from the English word order.
Table 13: Novel items used in the artificial language Pignon. The subject Voz was heard with each verb that causativized, and was featured as an image for all verbs. Each of the 5 objects occurred with 2 of the 10 verbs.

<table>
<thead>
<tr>
<th>Subject</th>
<th>Object</th>
<th>Verb</th>
<th>Causative Morpheme</th>
</tr>
</thead>
<tbody>
<tr>
<td>Voz</td>
<td>Mun</td>
<td>pel, flan</td>
<td>-ka</td>
</tr>
<tr>
<td>Voz</td>
<td>Puck</td>
<td>flooz, zin</td>
<td>-ka</td>
</tr>
<tr>
<td>Voz</td>
<td>Don</td>
<td>crem, zam</td>
<td>-ka</td>
</tr>
<tr>
<td>Voz</td>
<td>Flim</td>
<td>gorp, nem</td>
<td>-ka</td>
</tr>
<tr>
<td>Voz</td>
<td>Brink</td>
<td>tom, lim</td>
<td>-ka</td>
</tr>
</tbody>
</table>

A sample sentence that the participant would hear in the transitive causative form is flooz-ka Puck Voz, where the object is depicted as being sliced into three parts (Figure 10). A sample intransitive sentence is lim Brink, where a picture depicts an object as changing color, but participants only hear the verb in the intransitive form (Figure 11).

The sentences in the artificial language were heard in association with a picture. Each verb occurred with the subject Voz acting on the object half of the time regardless of whether or not the verb was used in a causative form in the sentence. Out of the 92 sentences, only 34 instances of a causative form were heard in both the 5 out of 10 and the 7 out of 10 conditions. The token frequency of how often the causative form was heard did not vary between conditions.

4.4.1.3 Procedure

Each participant was assigned to the 5 out of 10 or 7 out of 10 condition randomly. They were told that they would be learning a new language called Pignon by playing a computer game. They were asked to repeat sentences in the exposure phase in part one of the experiment, and in part two, they were asked to produce the sentence that best describes the image shown to them in Pignon.

Before completing the actual experiment, each participant undergoes a training phase in which they are trained to pay attention to the kind of patterns to be tested in the artificial language. This task is a simpler version of the task participants are asked to perform later on. The exposure phase of the training consists of a singular versus plural noun contrast, where a single image is shown with the name of the object, and multiple images of the object side-by-side are heard with the addition of a marker -po after the noun. The participants are then asked to describe the picture in a mini-test phase where they are tasked with producing the marker -po on the noun. Failure to correctly answer either of the test questions in the training task resulted in exclusion from the study. The primary purpose of the training phase is intended to get the participants accustomed to the nature of the task they have to perform.

Participants complete an exposure phase after the training phase, and are then asked to produce target sentences in a production test. The exposure phase consists of 92 sentences with 10 novel verbs that occurs in both the causative and intransitive form. The order of the sentences are controlled to facilitate learning the causative pattern on verbs. Each verb occurred at least 4 times in a row to allow the participants enough time to learn the pattern. The participants are also exposed to the subject and the objects separately while also hearing the sentence that contains them so that participants can decipher the parts of the sentence when heard as a whole; i.e. the subject Voz and the objects on their own were presented interspersed throughout the trials. Participants hear no more than 6 sentences in a row before being presented with the relevant subject and object again, as a reminder. The number of times the subject and objects were heard did not vary between trials.
Figure 10: Sentence: flooz-ka Puck Voz in VOS word order. Subject is shown to act on the object and slicing it into pieces with a knife.

Figure 11: Sentence: lim Brink in VO word order. Subject is shown to act on the object by painting it with a paint brush, but participants never hear a transitive causative form.

In the testing phase, participants are asked to produce 10 sentences: 10 novel verbs with 5 novel objects and 1 novel subject. Before being asked to describe the picture for the target sentence, participants heard a reminder sentence with the verb in the intransitive frame so that they could use the vocabulary to produce the causative form when applicable. Following the intransitive form of the verb, they were shown an image with the subject Voz acting on the object, and were asked to describe what was happening in the picture.

4.4.2. Predictions

There are two main predictions to make based on the proposed experiment. The first prediction is regarding the generalizability of a rule. Following the sufficiency principle, we expect participants to generalize the rule for adding -ka with the agent subject only when there is enough positive evidence to do so. In this experiment, 5 out of 10 verbs displaying a causative form does not constitute sufficient evidence for the causative rule to be extended to the other verb forms. 7 out of 10 verbs occurring with a causative form, on the other hand, is sufficient evidence for participants to assume that the rule is more general. We then
expect the rate of -ka uses with the agent subject to be lower among predicates that were not heard with the causative form in the first condition with only 5 verbs following the rule than in the condition with 7 predicates following the causativization rule. To be precise, we predict that participants will not use the causative form with any of the predicates that did not occur in the causative frame in the exposure phase in the 5 out of 10 condition. In the 7 out of 10 condition, we expect participants to use the causative form even with verbs that did not show the causative frame in the exposure phase. The extreme case of the prediction is shown in Figure 12.

The second prediction is in regards to theories of acquisition that invoke entrenchment as a learning mechanism. Here, as the verbs in the exposure phase follow a Zipfian distribution, the entrenchment theory of learning predicts a distinction in the use of purely intransitive verbs based on their frequency (e.g. Ambridge et al. 2008). In the 7 out of 10 condition, entrenchment predicts that participants will be less willing to use the causative form with a purely intransitive verb that occurs with a relatively high frequency than a verb that occurs with a lower frequency. This prediction only holds for the 7 out of 10 condition as the 5 out of 10 condition does not predict overgeneralization of any kind. In the 7 out of 10 condition, the verb gorp occurs 16 times as a pure intransitive in the exposure phase, while the two other pure intransitive verbs lim and zin occur only 4 times each. If participants do not treat gorp differently from lim or zin, then we find no support for entrenchment.

However, we also note that the prediction for distinguishing between theories that invoke entrenchment as a learning mechanism and theories that propose learning from evidence is only one-way in this experiment. If one does not find an entrenchment effect in the 7 out of 3 condition, then that constitutes evidence against entrenchment as a learning mechanism. In contrast, if we do find a frequency effect in this condition, that still does not support theories of entrenchment per se, as one may still find an effect of frequency when there is a generalizable or productive rule in place. Crucially, it does not provide evidence for entrenchment as a robust learning mechanism. In the 5 out of 10 condition, entrenchment theories still

Figure 12: Prediction for the 5 out of 10 condition with 5 -ka verbs and 5 no -ka verbs and 7 out of 10 condition with 7 -ka verbs and 3 verbs without -ka.
predict a difference in generalization between low frequency and high frequency verbs, but the Sufficiency Principle does not predict overgeneralization in this condition.

4.4.3. Results from Pilot Study

To test the functionality of the experiment, I ran a pilot study using the aforementioned design on 10 adult participants. Participants were undergraduates at the University of Pennsylvania, who were given course credit for completing the study. 3 participants were excluded from the analyses, as they did not produce any of the relevant forms in the testing phase. After exclusion, there were 3 participants in the 5 out of 10 condition (with 5 out of 10 causativizing verbs), and 4 participants in the 7 out of 10 condition (with 7 out of 10 causativizing verbs). The results of the pilot study are summarized in Figure 13.

![Figure 13: Pilot data results for 5 out of 10 condition with 5 -ka verbs and 5 no -ka verbs and 7 out of 10 condition with 7 -ka verbs and 3 verbs without -ka.](image)

As can be seen from the graphs, we find more instances of overgeneralization for adult participants in the 7 out of 10 condition. This is expected under the Sufficiency Principle. However, it is important to note that the predictions made by the Sufficiency Principle may not necessarily hold for adults, as they are specific to child language acquisition. This might explain why this numeric difference in the rates of -ka production of the verb with the agent subject (the causative form) between the two conditions did not reach significance in a Fisher’s Exact Test ($p = 0.5$).

Finally, it is important to note that these results cannot be due to the fact that participants memorized which verbs did not occur with a causative form, as it would then be easier to do so in the 7 out of 10 condition. Only 3 verbs occurred as pure intransitives in the exposure phase in the 7 out of 10 condition whereas there were 5 verbs that occurred as pure intransitives in the 5 out of 10 condition. Therefore, if participants were merely trying to memorize the relevant forms for each verb, we would expect the results to be reversed with more uses of -ka in the 5 out of 10 condition. If participants were trying to memorize which verbs did occur with -ka, then we would expect omission in the 7 out of 10 condition.
The results of the pilot study are promising, although no strong claims can be made due to the small number of participants. Moreover, the pilot study was conducted on adults, and not children. The proposed dissertation will include 20 more subjects in each condition for both adults and children to fully test out the predictions made in the previous section. However, I reiterate that the Sufficiency Principle is a model of child language acquisition, and does not make the same predictions for adults. The purpose of using adult participants is to primarily test the learnability of this artificial language in order to then test it on child participants. The adult participants in the pilot study were able to learn the language, and therefore, it will be possible to run the experiment in the dissertation.

5. The Acquisition of Passives

Passives have been a consistent subject of research in the field of language acquisition (e.g. Ambridge, Bidgood, Pine, Rowland, and Freudenthal 2016; Borer and Wexler 1987; Crawford 2012; De Villiers 1985; Demuth 1989; Pinker, Lebeaux, and Frost 1987) for two prominent reasons: the acquisition of passives involve A-chains, which are said to be acquired late under the maturation hypothesis (Borer and Wexler 1987; Hirsch and Wexler 2006; Terzi and Wexler 2002; i.a.), and second, it has been claimed that verb semantics affect the learnability of passives with actional verbs being acquired earlier than non-actional verbs such as psychological verbs (Maratsos, Fox, Becker, and Chalkley 1985; Pinker, Lebeaux, and Frost 1987; i.a.). I address these two claims in the proposed dissertation.

A majority of the work done on the acquisition of passives claim that the construction is acquired relatively late in English (e.g., Borer and Wexler 1987). A maturational hypothesis of language acquisition is a way of accounting for that distinction by arguing that certain grammatical processes do not biologically develop until a later age. This line of work argues that children under the age of 6 rarely produce passives, and that any passives found under that age are short passives; i.e., passives without a by-phrase. These passives are then claimed to be adjectival passives, and not verbal passives, where there is no formation of an A-chain. The maturational hypothesis also attempts to explain the asymmetry between the learnability of passives of actional versus non-actional verbs by arguing that non-actional verbs do not make good adjectival passives, and are therefore, not learned earlier. I argue against these claims in the proposed dissertation.

The Sufficiency Principle also allows us to make predictions regarding the age at which passives are learned. We can investigate the occurrence of the passive in the input, and accordingly, show the stage at which we expect them to be acquired. Using the Sufficiency Principle, we can determine the point where there is sufficient positive evidence in the input for the passive construction. I will then compare my findings with the predictions of other approaches and the results of experimental work on children’s comprehension of passives.

5.1. Proposed Analysis

In the proposed dissertation, I argue that corpus data reveal children’s knowledge of both long and short passives. Previous work has suggested that children only spontaneously produce short passives, but not long passives with a by-phrase (e.g. Hirsch and Wexler 2006). This claim has been used to support the maturation hypothesis (e.g. Borer and Wexler 1987). Contrary to what has been argued, I find some evidence for spontaneous production of passives in the production data in CHILDES.

(29) a. ./Braunwald/0diary/020705.cha:*CHI: Sammy was hit by a car . (2;7)
    ./Kuczaj/030721.cha:*CHI: no a monarch butterfly was killed by a bird . (3;7)
    b. ./Kuczaj/030823.cha:*CHI: oh Dad I heared that man say he was never bitten by that (3;8)
The examples in (29) were obtained by searching CHILDES for all child-produced data containing by. I then combed through the data by hand, and found instances of the long passive produced as young as 2;7. Under the maturation hypothesis of language acquisition, (29) is already surprising.

Empirical evidence on children’s comprehension of English verbal passives remains divided on whether they perform poorly in comprehending these constructions (e.g. Borer and Wexler 1987) or whether they are able to learn and use them early on around the age of 3 (Crain, Thornton, and Murasugi 2009; Demuth 1989; Pinker, Lebeaux, and Frost 1987; i.a.). Much of the past work has also found an asymmetry between actional and non-actional passives (e.g. Fox and Grodzinsky 1998; Maratsos, Fox, Becker, and Chalkley 1985). The proposed analysis will show that these effects can easily be accounted for when the primary linguistic data is examined for the availability of these constructions in the input. In future work, I will examine the role of the input in the acquisition of passives. For now, I provide an overview of the reasoning behind pursuing an analysis that addresses the acquisition of passives in relation to the input received by the learner.

Some accounts such as Bever (1970) argue that the acquisition of passives is late as they are infrequent in the input. Kline and Demuth (2010) also suggest that the differences in the late acquisition of passives in English, and the early acquisition of passives in Sesotho may be the result of input differences. However, their investigation was based on a single corpus of English, the Brown Corpus (Brown 1973). I aim to provide a larger basis for this claim by examining all the corpus data available for North American English in CHILDES. Previous work has also attempted to attribute the asymmetry between actional and non-actional passives to the low frequency of non-actional passives in the input (Gordon and Chafetz 1990).

Although previous research attributes the late acquisition of English passives to their sparsity in the input, it can be argued that low frequency in the usage of passives need not necessarily imply that passives are not learned early on. The small number of child production data with passives can simply mean that passives are used at the same rate in conversation by both adults and children. Note that the small number of passive occurrences in the adult production data does not imply a lack of understanding of passives for adults, and the empirical evidence on children’s knowledge of passives is divided. Furthermore, claims that children learning English have trouble with passives also stems from the low frequency of passives with by-phrases in the input. These by-phrases are able to distinguish between adjectival and verbal passives with certainty. The lack of by-phrases with passives in child data serves as evidence against the idea that children have mastered the passive construction. However, as shown earlier, a search through all the corpora of children learning English in CHILDES reveals some production of by-phrases as well. I aim to show that the low frequency of by-phrases in child data is not significantly different from the adults’ production of passives with by-phrases.

The late acquisition of passives is also found in languages other than English. Children learning German have also been noted to acquire passives around the age of 5 (De Villiers 1984). There has been some corpus work done on the acquisition of German passives in comparison with the future tense construction (e.g., Abbot-Smith and Behrens 2006), but these works do not directly address the timing and frequency of the production of passives in relation to the frequency of passives in the input. The proposed analysis for passives will also include cross-linguistic data from German to compare with English to determine the nature of the acquisition of the passive construction.

Along the same lines of the maturation hypothesis, Babyonyshev, Ganger, Pesetsky, and Wexler (2001) propose that the late acquisition of passives can perhaps be attributed to the lack of external arguments,
and not the maturation of A-chains. Throughout the proposed dissertation, I show how structures lacking an external argument are acquired. In raising constructions, unaccusative verbs are acquired on the basis of expletives, and as expletives are relative rare in the input, the raising property of these verbs emerges later on. In distinguishing unergative intransitives from unaccusative intransitives in chapter 4, we saw that children make use of notions such as intentionality, and there is no evidence that unaccusatives are acquired late. Although the property of having an external argument may indeed be readily available due to innate mechanisms, the claim cannot be made that children have difficulty with structures that lack an external argument. They may simply have to learn it from the input when their language shows evidence for it. The proposed analysis for the acquisition of passives will assume that learners can readily parse passives and structures that lack an external argument, but that the input must provide them with the language specific information to do so. There is nothing inherently difficult about the lack of external arguments in syntactic structures.

In the proposed dissertation, I will also examine the input received by children learning English for passive constructions. As we have seen earlier, children do use verbal passives, and appear to have at least some mastery of the construction. I will compare the learner’s use of passives to that of passives in the input. More specifically, using the Sufficiency Principle, I will make predictions regarding when the passive construction can be learned by the child given the frequency of the construction in the input. The Sufficiency Principle allows us determine the point at which the construction becomes productive in child grammar. And finally, we can compare the experimental findings regarding children’s comprehension of passives in relation to our expectations given the Sufficiency Principle. These future steps are to be addressed in my dissertation.

6. Timeline

- March 2018 – May 2018 Run experiment
- May 2018 – June 2018 Write Chapter 2
- June 2018 – September 2018 Write Chapter 3
- September 2018 – November 2018 Write Chapter 4
- November 2018 – February 2019 Write Chapter 5
- March 2019 Write Introduction
- April 2019 Write Conclusion
- May 2019 Defend Dissertation

References


Austin, Alison (2010). When children learn more than what they are taught: regularization in child and adult learners. University of Rochester.


Sherman, Janet Cohen and Barbara Lust (1993). “Children are in control”. In: Cognition 46.1, pp. 1–51.

Appendix

Subject control verbs (42 total):
bother, claim, come, leave, look forward to, neglect, petition, pretend, wait, care, like, prepare, pretend, scramble, see, think, volunteer, want, attach, decide, forget, hope, plan, stick, try, use, agree, attempt, hate, offer, pay, refuse, arrange, choose, learn, long, mean, seek, dare, desire, ask, vow

Raising verbs (15 total):

52
appear, get, happen, proceed, seem, start out, stay, tend, threaten, about, likely, sure, going, set, bound, suppose

Ambiguous control and raising verbs (9 total):
fail, begin, continue, manage, need, promise, stop, grow, start

R code used for calculating the number of predicates necessary to disambiguate between raising and control verb classes:

```r
p = 0.003
q = 0.052
for (n in 1:1000) {
  for (m in 1:n) {
    if (pbinom(m, n, p)>=0.99 & pbinom(m, n, q)<=0.01) {
      output<-c(n, m)
      print(output)
      break
    }
  }
}
```

Adam’s Verb List (208 total):
go, come, laugh, cry, fall, change, shake, move, break, stay, hurt, turn, drop, pop, open, fit, grow, tickle, live, blow, shine, push, drip, lose, tear, roll, twinkle, ring, close, bake, fold, taste, hang, call, slip, work, crack, burn, bump, feel, bend, wind, flash, tip, hide, smash, sail, blast, print, dry, sneeze, play, sit, stand, jump, lie, walk, drive, climb, camping, swim, sweep, bite, work, crawl, wait, listen, hurry, run, dance, eat, sleep, squeak, point, paint, fly, sing, squeeze, wake, fight, kiss, talk, finish, pack, squeal, dig, care, growl, tease, pay, exercise, stir, swing, pinch, quack, hug, swallow, rest, leave, rock, shave, back, fire, smoke, dress, scream, marry, sow, ski, fish, look, put, read, get, like, hop, see, remember, hit, be, find, give, beat, ride, write, wipe, comb, want, drink, draw, pull, pick, fix, take, throw, kick, watch, stop, buy, check, wear, keep, happen, matter, scratch, cook, step, show, knock, catch, use, pour, carry, need, build, dip, fasten, save, hold, make, do, have, miss, bring, help, press, hand, chew, park, know, shoot, ask, let, cut, try, say, spank, count, excuse, reach, frighten, dump, stuck, skip, pretend, think, mix, hate, pat, tie, tell, rope, mail, spell, learn, lift, cross, wash, zip, seem, mock, match, rustle, punch, screw, plug, serve, spill

Ross’s Verb List (121 total):
go, come, cry, turn, move, drop, shut, stay, close, fall, hurt, live, open, feel, call, sit, break, twist, rip, slip, tickle, tumble, work, pop, do, play, try, nap, see, kiss, look, finish, drive, read, jump, yell, leave, sleep, fool around, dare, bite, eat, scratch, work, stand, blow, spit, fly, swim, burp, talk, growl, sing, run, jog, ride, wake, fight, climb, whisper, point, knock, smile, wait, scream, forget, know, be, fix, like, give, get, have, take, put, think, hurry, click, want, wear, let, say, need, show, help, carry, buy, bug, hit, find, cut, feed, pull, hold, touch, make, throw, record, push, kill, drink, steal, flush, scare, hear, transform, repeat, taste, salt, stop, shoot, pick, happen, bump, use, brush, spank, love, list, cook, bring