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How We Learn to Talk About Events:

Linguistic and Conceptual Constraints on Verb Learning

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ABSTRACT

How We Learn to Talk About Events:

Linguistic and Conceptual Constraints on Verb Learning

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This dissertation investigates the mapping between linguistic and conceptual event representations and the implications of this mapping for the acquisition of verbs labeling causative events. From infancy, we represent causative events as being composed of a set of subevents associated in a hierarchical structure that reflects their partonomic and taxonomic relationships to one another. Our linguistic representations of events are intimately tied to our conceptual representations, and languages reflect this complex internal structure in the grammar of the causative construction. The studies reported here offer a clearer picture of the range of meanings that language learners are willing to encode in single verbs associated with causative events and how the hypotheses they postulate about the meanings of novel verbs are constrained by conceptual and linguistic factors.

I present results from four preferential looking studies investigating the limits that 2–year-old children and adults place on their hypotheses about the meanings of novel verbs associated with causative events. Experiments 1&2 demonstrate that 2–year-old children have access to the same

complex representations for causative events that adults do and that both groups can use verb-specific subcategorization information to identify and label the subparts of these events. Specifically, both groups mapped novel verbs in unaccusative intransitive syntactic frames onto the result of a causative event and novel verbs in unergative intransitive frames onto the agent's activity. For novel verbs presented in transitive frames, 2-year-olds demonstrated a bias to interpret them as labels for a causative event, whereas adults tended to map them onto the agent's activity. Experiments 3&4 reveal that as long as structural constraints on the mapping between verb syntax and semantics are satisfied, 2-year-olds can be flexible in the specificity of the semantic content they assign to their representation of a causative.

Taken together, these results provide support to the argument that children's early verb representations are abstract in nature. They suggest, moreover, that adults and 2-year-olds face word-learning situations with different resources and that they bring different strategies to the task of learning new words that stem from differences in their experience with the target language and the world.

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Chapter 1

Introduction

Don't forget that compared to a grownup person every baby is a genius.
Think of the capacity to learn!
The freshness, the temperament, the will of a baby a few months old!
- May Sarton

To learn the meaning of a word, a language learner must map some linguistic unit (spoken, signed, or written) onto a representation of the world provided by the conceptual system. The process of figuring out exactly which conceptual bits are associated with which bits of language involves the generation of a set of hypotheses about the mapping between form and meaning and a gradual rejection of the hypotheses that don't hold up in the face of new information about a given word. A classic puzzle in the study of language acquisition concerns what constraints determine the set of hypotheses that a learner generates for the meaning of a novel word and what kinds of information help the learner to narrow down that set. It is certainly the case that a learner's own experience, e.g., with the world or with the language she is learning, can help her to distinguish between probable and improbable hypotheses about word meaning. Infants are not blank slates, however, and they come pre-equipped with default assumptions about language and the world that guide word learning. The goal of this dissertation is to investigate the nature of some of these constraints and how they play out in children and adults trying to figure out the meanings of verbs labeling causative events.

When we learn certain kinds of novel words (e.g., nouns and verbs), what we are learning are labels for categories of things in the world. The word “dog,” for example, refers to the category of entities in the world that we think of as *dogs*, and the word “jump” refers to the category of events in the world that we think of as *jumping*. A large literature has grown up around the conceptual biases that guide the acquisition of novel nouns and the kinds of categories that children assign to them, demonstrating, for example, that children begin by assuming that novel count nouns refer to whole objects rather than parts of objects, that each whole object has a single distinct label, and that those labels refer to basic-level categories rather than superordinate categories or particular individuals (e.g., Markman 1993, Waxman 1990; see Woodward 2000 for a cogent summary of the constraints on noun learning). However, the corresponding questions about novel verbs are just beginning to be investigated: i.e., what categories of events a novel verb can be extended to include and what kinds of constraints guide their acquisition.

It is a well-documented fact that children learn labels for events, i.e., verbs, later than they learn labels for objects, i.e., nouns. Traditionally, it was assumed that children learned what words meant by pairing word-sized units that they had managed to pull out of the speech (or gesture) stream with objects and events that they observed in the extralinguistic context—mapping words onto things in the world. On this account, the delay in verb acquisition has been attributed to differences in the complexity of the concepts labeled by the two grammatical classes. Nouns, because they typically describe objects in the world that are concrete and observable, are taken to be simpler and therefore easier to learn, whereas verbs, which label relations between objects rather than objects themselves, are more difficult to acquire (e.g., Gentner 1982, Gentner & Boroditsky 2001).

There are problems with the word-to-world mapping account of word learning, however, which may be summarized by the simple observation that there is rarely a clear one-to-one mapping between the linguistic signal and the extralinguistic context. The action going on in the world is complex and continuous. Even in a single spatially and temporally bounded unit of the world, there are often many events going on at once, overlapping with each other in time, space, and participants, and it is unclear in this sort of situation how a language learner would be able to pick out exactly which single event (or set of related events) to associate with a novel verb on the basis of nothing more than a single word label. What language learners need in this kind of situation is some way to constrain their hypotheses about what novel verbs can mean—to give them some clue about what it is that they're supposed to be attending to in the world to link up to the words and sentences that they're hearing used to describe that world.

Since concepts are so closely tied to the meanings of words, we might expect that verb learners are guided by conceptual constraints on event representations. According to this theory, the hypotheses that language learners make about the mapping between words and the world would be limited by the way that we perceive disordered happenings in the world to cohere as temporally bounded events, and by the way that those events are related to each other in conceptual hierarchies. Indeed, experimental studies of infant perception and categorization of events have demonstrated that infants are sensitive to just those features of events that are relevant for semantic representation, including the number of relevant participants in an event, their path and manner of motion, and the causal relationships between them (e.g., Gordon 2004, Leslie 1982, Pruden & Hirsh-Pasek 2006, Pulverman & Golinkoff 2004).

Recent accounts of word learning have proposed, moreover, that it is the information requirements of noun learning compared with those of learning other kinds of words that determine the order of acquisition of grammatical categories (e.g., Gillette et al. 1999, Gleitman et al. 2005, Landau & Gleitman 1985, Snedeker & Gleitman 2004): that is, not all words are learnable from a single kind of input evidence. It is well established that there are systematic regularities between the meaning of verbs and they way they can be used, such that verbs that refer to similar event types can occur in similar sentence structures (e.g., Carter 1976, Gruber 1965, Jackendoff 1990, Levin 1993). For a learner who is aware of this correspondence, the syntactic properties of verbs should provide rich cues to their meanings: ergo, in those cases in which it is impossible to rely on a mapping of words to things and events in the world, she should be able to use cues from the linguistic input to narrow down her hypotheses about the meaning of a novel verb. Consistent with this hypothesis, often referred to as syntactic bootstrapping, there is clear experimental evidence demonstrating that children as young as 14 months of age may use cues from syntax to guide their comprehension of novel verbs, even if they are not yet themselves able to produce syntactically complex utterances (e.g., Fisher et al. 1994, Gleitman 1990, Naigles 1990).

In this dissertation, I will present a combination of interdisciplinary literature review and new experimental data designed to investigate how constraints imposed by the mapping between meaning and conceptual and linguistic representations of events guide verb learning in children and adults.

The events that I will be discussing are causatives, which can be characterized conceptually as complex events in which one entity, the agent, performs some action that gives rise to a change of state (e.g., motion or location) in another entity, the patient (e.g., Kim 1971/1993b, Mackie 1965/1993, Pietroski 2000, Thomson 1977), e.g., a girl drops a glass, causing it to break. In general, causative events can be thought of as being composed of three distinct subparts, as in (1).

(1) $\underbrace{\text{[girl drops glass]}}_{\text{MEANS}}$ CAUSE $\underbrace{\text{[glass breaks]}}_{\text{RESULT}}$

The first of these subparts, which I will refer to as the MEANS subevent, specifies the girl's action. The third subpart, which I will refer to as the RESULT subevent, specifies the change of state that the glass undergoes. The intervening subpart CAUSE specifies the nature of the relationship between the girl's action and the change of state undergone by the glass: viz., that the event of the girl's dropping of the glass directly results in the event of the glass's breaking. These types of events lend themselves well to the questions at hand not only because, as I will outline in Chapter 3, different combinations of the subparts of a causative can be lexicalized in a single verb, but also because there are syntactic frames and frame alternations that provide robust linguistic cues to the event subparts encoded by verbs labeling causative events.

For example, if our glass-breaking girl accomplishes her goal by singing at a high pitch rather than by dropping the glass, as represented in (2), we might describe this complex causative chain of events with any of the sentences in (3–5):

(2) $\underbrace{\text{[girl sings]}}_{\text{MEANS}}$ CAUSE $\underbrace{\text{[glass breaks]}}_{\text{RESULT}}$

(3) The glass broke.

(4) The girl sang.

(5) a. The girl sang a note.

b. The girl broke the glass.

Note that a verb presented in an unaccusative intransitive frame, as in (3), can only be labeling what happens to the glass—the result subevent of the complex causative—and that a verb presented in an unergative intransitive frame, as in (4), labels what the girl is doing—the means subevent of the complex causative. A verb presented in a transitive frame, as in (5), is ambiguous, however: some verbs in this frame appear to label the means of the causative event (5a) and others the result (5b).

In the case of so-called causative verbs, which can occur both in a transitive frame an in an unaccusative intransitive frame, as in the causative alternation (6), the verb in the transitive variant encodes both RESULT and causation. The sentence in (6b) can be summarized as "the girl performed some unspecified action that caused the glass to break," and the sentence in (7) is impossible precisely because the verb *break* in this frame encodes the notion of causation as well as the result.

(6) a. The glass broke. RESULT

b. The girl broke the glass. CAUSE + RESULT

(7) # The girl broke the glass, but she didn't affect it.[1]

It is important to point out that I will not be addressing philosophical notions of causality in this dissertation, and you will not find answers here to your questions about determinism, free-will, morality, responsibility, or intention. Nor will I will deal with abstract causative events that involve changes to states of mind (8a,b) or global politics (8c,d), or even with concrete changes of state that involve complex causal chains (8e,f).[2]

(8) a. Record Sales of Sleeping Pills Are Causing Worries

b. Podcasting - a word still causing confusion

c. Typhoid May Have Caused Fall of Athens, Study Finds

d. Bush Caused 9/11

e. U.S. Meteorologist Says Russian Inventors Caused Hurricane Katrina

f. James Frey Caused Oprah to Gain Weight

On the contrary, the causative relationships that I'll be dealing with are relatively small-scale, both temporally and spatially, and involve more or less direct observable physical

[1] The # symbol is used here and throughout the text to mark sentences that, while grammatical, describe a contradictory state of affairs.

[2] All of the examples in (8) are headlines retrieved April 18, 2006 in a search for "caused" at www.google.com

causation (e.g., contact between agent and patient[3]) brought about by an intentional human agent. Moreover, although they are certainly issues that are relevant to event perception and description, I will not have anything new to say about how children learn what can be a cause or how causation works (we assume that our language learners bring some sophistication with causative events to these tasks), what event features give rise to a perception of causality (see Leslie 1982, 1984a, 1984b for details on the perception of causality in infants), or what the proper linguistic representation of causatives is (I will be assuming that they are represented as syntactic decompositions with CAUSE as a light verb that selects for an XP that specifies the result of the event; see Chapter 3 for a justification and summary of this position).

As pointed out by Talmy (1985), when we are presented with an event that is represented with a complex internal structure, like these causatives, although all of the interrelated subparts (in this case MEANS, CAUSE, and RESULT) are necessarily copresent wherever that event is encountered, a sentence describing the event “can pick out different subsets of the factors for explicit reference, leaving the remainder unmentioned" (p. 303). Languages represent this kind of internal structure directly in the grammar (e.g., Hale & Keyser 1993, Halle & Marantz 1993, Harley 1995, Jackendoff 1990, Krifka 1998, Levin & Rappaport Hovav 1995), and so each of these different kinds of event construal maps to a specific kind of linguistic representation. It is not the case, however, that just any combination of conceptual primitives may be encoded as a single verb in every language, suggesting that there are constraints on lexicalizable structures.

[3] Note, however, that contact should not be confused with causation, as it is neither necessary nor sufficient for the perception of causality.

Traditionally, questions about the principles restricting lexicalization have been investigated by looking at crosslinguistic lexicalization patterns (e.g., Embick 2004, Hale & Keyser 1993, Harley 1996, Haspelmath 1993, Jackendoff 1990, Kratzer 1996, Levin & Rappaport Hovav 1995, Lidz 1998, Marantz 1997, Rappaport Hovav & Levin 1998, Talmy 1985) or, more recently, through psycholinguistic experiments on the mapping between conceptual structures and language in adults (e.g., Lakusta & Landau 2005, Wolff 2003). Another way of approaching this issue, however, would be to ask whether children's acquisition of novel verbs is guided by the same principles that restrict adult lexicalization.

The period of development around 2 years of age, which corresponds approximately to the two-word stage of performance, is crucial for studies of language acquisition because the child still has a lot of words to learn and yet is just beginning to use syntax in her own production. Logically, then, it is at this time that a mechanism like syntactic bootstrapping would be most useful for the child, and, interestingly, it is exactly during this stage that the child experiences a rapid increase in the acquisition of new vocabulary, and especially of verbs. Previous studies have demonstrated that children of this age have access to the same complex representations for causative events that adults do (e.g., Bunger & Lidz 2004; Leslie 1982, 1984b). We might ask, then, whether children's lexicalizations are subject to the same constraints. Phrasing the issue in terms of acquisition will allow us to investigate how the heuristics that language learners use to narrow their hypothesis space change as learners gain more experience with the world and with their target language.

In the chapters that follow, I summarize the literature on the conceptual and linguistic representation of events and describe a set of four experiments designed to investigate the range of meanings that language learners are willing to encode in single verbs associated with causative events and how their hypothesis space is limited by constraints on the mapping between conceptual and linguistic event representations. In Chapter 2, I describe the hierarchical nature of the relationship between conceptual event representations and summarize the experimental literature investigating the features of events that are relevant for event perception and description. In Chapter 3, I describe the mapping between conceptual and linguistic representations of events and identify a linguistic constraint on verb meaning that may account for a crosslinguistic lexical gap in the set of verbs labeling causative events. In Chapter 4, I summarize the literature on verb learning and outline a specific set of questions to investigate experimentally: viz., what kinds of syntactic information guide the interpretation of novel verbs, which combinations of the subparts of a causative event language learners are willing to encode in a single verb, how specific they are about the event features they're encoding, and how they deal with conflicts between hypothesized verb meanings and new information from the extralinguistic context. In Chapters 5–7, I describe the set of experiments designed to investigate these questions: Chapter 5 provides details about the study design and subject populations. In Chapters 6 and 7, I describe the results of experiments probing the meanings that adults and 2–year-old children are willing to encode in single verbs labeling causative events. In Chapter 8, I summarize these results in terms of constraints on word learning and briefly discuss the relevance of this work in the ongoing debate over the level of abstraction present in children's early representations.

This dissertation is, in part, intended to supplement the insights into the mapping between language and event structure gained from collaboration at the interfaces of syntax and semantics with related research in psycholinguistics and conceptual psychology, bringing together the study of events as grammatical phenomena with the study of how we perceive and categorize events using conceptual structures. This research will begin to bridge the gaps between work examining the conceptual representation of event structure, work examining the linguistic expression of event structure, and work examining the role that cognitive tools and constraints play in language acquisition. Together, these three areas raise important questions about the effect of prelinguistic event representations on word learning, the complex mapping between the linguistic and conceptual representations of events, and the nature of the cognitive tools that drive our acquisition and use of language.

Chapter 2

Event Structure

The activity going on the world around us is continuous and chaotic. To make sense of this disorder, the human mind relies on structured representations of events that capture abstract spatial, temporal, and causal information about actions in the world. These event representations are central to our understanding, recollection, and description of the physical world, and they play an important role in guiding our interactions with it. Knowledge of causal connections, in particular, allows us to explain the occurrence of certain events and to predict and possibly control future events (e.g., Kim 1973/1993a, Pietroski 2000, Zacks & Tversky 2001).

The activity that occurs in a given place during a given unit of time may be construed as a whole host of events, each of which is perceived to have a discrete beginning and end. Imagine, for example, a unit of time corresponding to a single inning of a baseball game. Entirely unconstrained by the rules of baseball, activity in the stadium will continue to go on after this period of time: if it is not the last inning, there will be more baseball, and even after the game is over and the players and the fans go home, someone will come to mow the outfield, etc. This single inning, on the other hand, bound as it is by time, space, and social convention, constitutes an <u>event</u>: an inning is generally understood as beginning when the previous inning is over and as ending when both teams have had turns at bat and three players from each team have been called out. It is important to point out that events are defined by the construer and not by the world: i.e., what makes this inning (but not, say, any group of people playing with balls and running around) an event is that we understand something about the game of baseball, constrained as it is by rules defined according to social convention, and the relevance of a certain sequence of activities in the world to the routine of the game.

At the same time that this inning is going on, moreover, there are multiple other events going on in the stadium; just a few of these are listed in (9).[4]

(9) the top of the inning, Zambrano's pitch, the first batter's bunt, the pitcher's throw to the first baseman, the first baseman's catch, the second batter's strike-out, the catcher's adjustment, the third batter's hit, the batter's run to first base, the fourth batter's fly-out, the catcher's signal to the pitcher, the pitcher's wind-up, the pitcher's release of the ball, the ball's journey to home plate, the batter's swing, the batter's hit, the ball's pop fly, the outfielder's grab for the ball, the outfielder's catch, the cheering from the dugout, the umpire's spitting, the hot dog vendor's sale, the fan's beer run, the bottom of the inning, etc… [5]

We could extend this catalogue of the events that take place during a single inning of a baseball game by continuing to list each one separately, but in doing so we would be overlooking a useful generalization about the nature of events. Indeed, it seems clear even from the partial list given in (9) that events can <u>overlap</u> with each other in certain ways, viz., in time, in space, and in event participants and the changes they undergo: the event of Zambrano's pitch, for example, overlaps with the events of the pitcher's wind-up, the pitcher's release of the ball, and the ball's journey to home plate in exactly these ways. While none of these latter events by itself constitutes Zambrano's pitch, they do share relevant event features with it, and together, they seem to not only provide a more detailed description, but to actually constitute <u>parts</u> of the pitching event. It

[4] I use the convention here, common in the philosophical literature on events, of using nominalizations to refer to events (e.g., Kim 1971/1993b, Thomson 1977, Pietroski 2000).
[5] These events are based loosely on those reported in the play-by-play of the 6th inning of the 4/19/2006 Cincinati Reds at Chicago Cubs game, available on sportsillustrated.cnn.com

is this observation that has led philosophers interested in event representation to conclude that events can be hierarchically related. The goal of this chapter is to clarify the nature of this hierarchy, and to discuss its implications for event perception and for language use and acquisition.

2.1 Parts of Events

The argument that events can be related in a partonomic hierarchy goes roughly like this: A single action in the world may represented in multiple ways, and many of the event descriptions provided for a single action will involve identical sets of participants and will overlap in spatial and temporal features. Take, for example, the 1865 assassination of U.S. President Abraham Lincoln by the actor John Wilkes Booth.[6] On April 14th, while Lincoln was watching a play at Ford's Theater, Booth entered the President's state box, waited for an outburst of laughter that would conceal the noise of his gunshot, and shot Lincoln at point-blank range in the back of the head with a Derringer pistol, mortally wounding him. On the basis of these facts, we might use either of the sentences in (10) to describe the assassination.

(10) a. Booth killed Lincoln.

b. Booth shot Lincoln.

Note that not only do both of these sentences provide accurate descriptions of the activity, but they describe events that are closely related in certain details. The events overlap in

[6] The extended example that follows is respectfully adapted from Pietroski 2000.

time (April 14th) and space (Ford's Theater), and both describe an intentional action that involves the same participants: the actor Booth and the patient Lincoln. On the basis of these shared features, it is tempting to equate the two events with one another, that is, to say that rather than identifying separate actions in the world, Booth's shooting of Lincoln was Booth's killing of Lincoln. Note, however, that there are several problems with this identification.

The first of these is that shooting is not the same as killing. If I say that "X killed Y," I mean something like "X caused Y to die," but *shoot* does not mean "cause to die." If I say that "X shot Y," what I mean is that "X caused Y to be penetrated by a bullet by firing a gun." Indeed, shooting is neither a necessary nor a sufficient condition of killing: an actor can shoot Y without causing Y's death, and can kill Y without shooting Y. On the night of Lincoln's assassination, Booth also had a hunting knife with him that would have done the job quite nicely.

The second problem with identifying Booth's shooting of Lincoln with Booth's killing of Lincoln is that the two events don't overlap completely in relevant physical details or spatiotemporal properties: i.e., while they may be descriptions of the same action, they provide different construals of that action. Consider the following facts about the assassination: *1*) the shooting and the killing both involve the same actor (Booth), patient (Lincoln), and, although it is not explicitly identified in (10), the same instrument (a pistol); *2*) Booth shot Lincoln in the head; and *3*) Booth killed Lincoln by shooting him, or, as put more colorfully in a History Channel discussion forum on the Civil War, "with a bullet in the brain."[7] If the shooting and the killing are completely equivalent events, it should be the case that any description that we

[7] Retrieved April 26, 2006, from http://boards.historychannel.com/thread.jspa?forumID=100&threadID=300034462&messageID=300417245&start=-1

provide of one of the events should also be true of the other (at a given time, in some possible world, relative to a particular judge, etc.). The pattern of semantic anomalies in (11), however, makes it clear that this is not the case. Note that while both events can be described as being performed "with a pistol," only the shooting can be described as "in the head," and only the killing as "with a bullet to the brain."

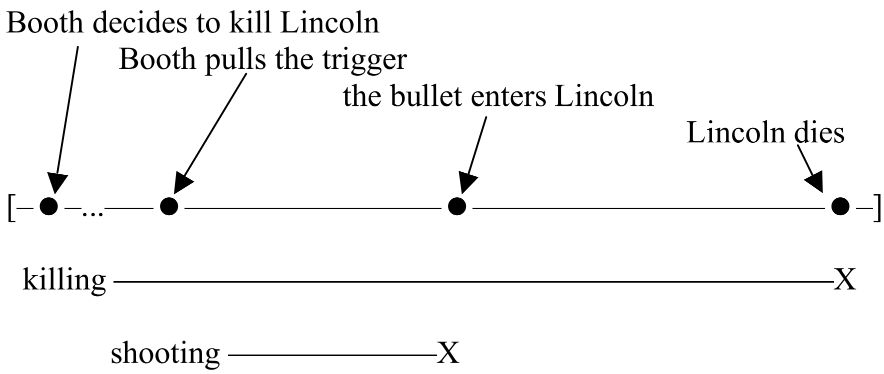
(11) a. Booth killed Lincoln (with a pistol) (# in the head) (with a bullet in the brain).

b. Booth shot Lincoln (with a pistol) (in the head) (# with a bullet in the brain).

Note, furthermore, that the spatiotemporal location of the beginning and end of these two events is not the same. A shooting begins when the actor pulls the trigger on a gun to successfully release a bullet and ends when the bullet successfully enters the victim. A killing, on the other hand, begins when the actor first sets in motion the circumstances that will lead to the death of the victim (in the case of an accidental shooting, this may also be the point at which the actor pulls the trigger) and does not end until the victim is dead. In the case of Lincoln's assassination, Booth and his co-conspirators set their plan to kill Lincoln in motion long before and miles away from the time and place at which Booth pulled the trigger on the gun, and although the bullet shot by Booth entered Lincoln on April 14th in Ford's Theater, Lincoln's death did not actually occur until April 15th and in a private home across the street from the theater.

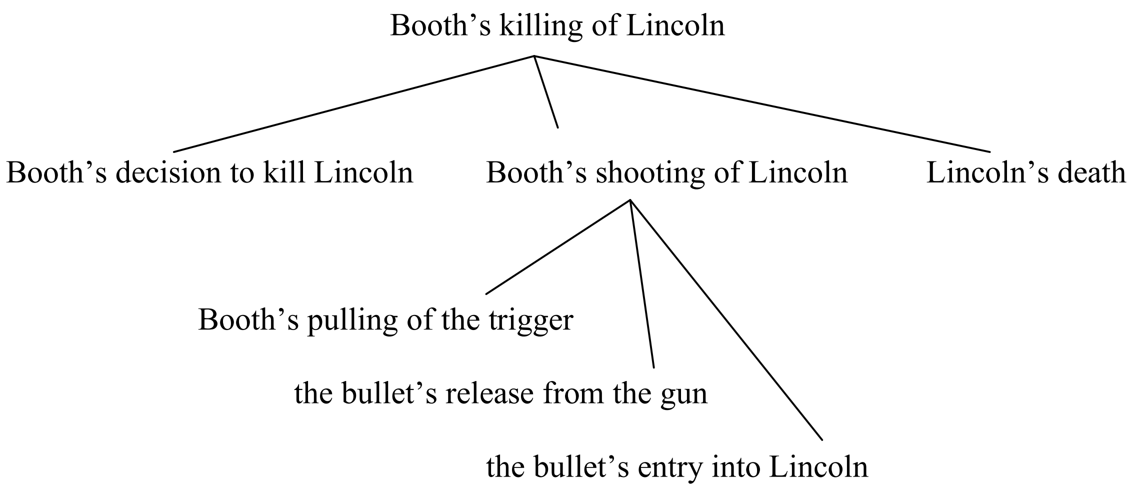
The diagram in (12) depicts a timeline of the events relevant to Booth's shooting of Lincoln and Booth's killing of Lincoln, beginning with Booth's decision to kill Lincoln and ending with Lincoln's death. From this diagram, it is clear that although they do overlap in time, the killing event actually both begins before and ends after the shooting event.

(12)



In light of these inconsistencies, it seems clear that Booth's shooting of Lincoln is not, in fact, identical with Booth's killing of Lincoln, and yet, we don't want to give up the idea that the shooting is somehow inseparable from the killing. Philosophers of language have proposed that the proper solution to this quandary is to recognize that some events have other events as parts (e.g., Pietroski 2000, Thomson 1977, Zacks & Tversky 2001). The idea here is that events have <u>internal structure</u> such that at least some of the events that correspond to a single temporally bounded activity in the world may be hierarchically related, with complex events being comprised of multiple subevents which may themselves be complex. In the case of Lincoln's assassination, we would say that Booth's shooting of Lincoln is just one of the subevents that make up the complex event of Booth's killing of Lincoln. Booth's shooting is itself a complex event, moreover, and may be decomposed into something like the subparts listed in (13).

(13)



This partonomic construal of events allows us to describe a single action with an event description that captures either the entire action, e.g., Booth's killing of Lincoln, or with one that captures only part of that action, e.g., Booth's shooting of Lincoln or Lincoln's death, and captures the idea that the shooting represents a crucial part of the killing.[8]

Returning to the baseball example introduced at the beginning of this chapter, many of the distinct events that take place during a single inning of a baseball game, as listed in (9), may be related in a partonomic hierarchy as in (14). This partonomy, like the one constructed to represent the relation between the events associated with Lincoln's assassination, lays bare the internal structure of events in the baseball inning. Among other things, this structure reflects the fact that the event described in (9) as Zambrano's pitch is a complex event comprised of multiple subevents, including the pitcher's wind-up, the pitcher's release of the ball, and the ball's

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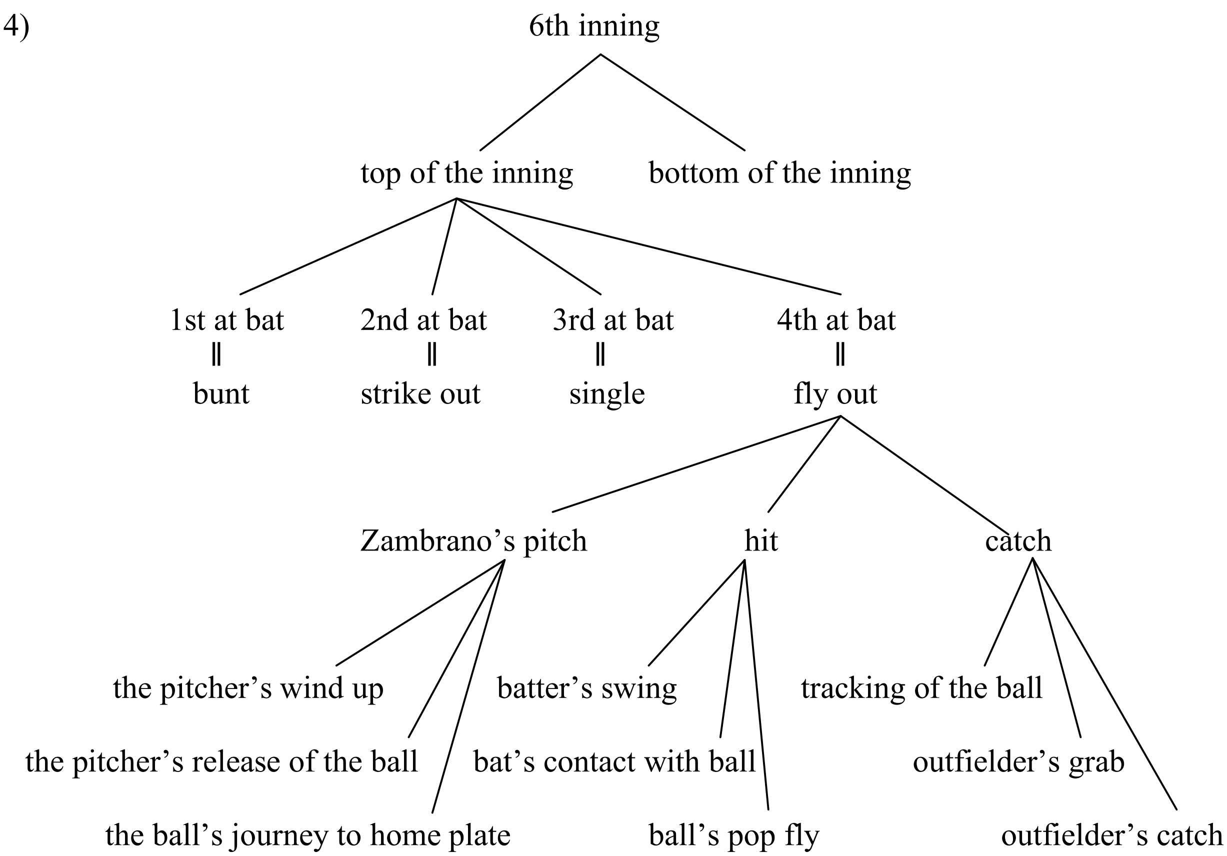
[8] Galambos & Rips (1982) would describe the shooting as a "central" part of the killing event. In a reaction time study, they demonstrated that the centrality of an event to a given routine (and not just the temporal organization of a sequence of scripted events) significantly affects the speed of decisions about whether a given pair of events is related.

journey to home plate. Likewise, the complex event described as the batter's hit is comprised of subevents that include the batter's swing, the bat's contact with the ball, and the ball's pop fly.

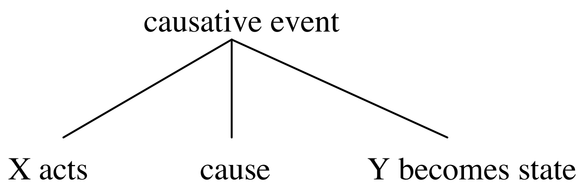
(14)



Note, however, that there are several events that were identified in (9) as taking place during the inning but that are not included in this partonomic hierarchy: e.g., the cheering from the dugout, the umpire's spitting, the hot dog vendor's sale, and the fan's beer run. This deliberate omission demonstrates that it is not the case that all events that overlap in spatiotemporal features or event participants are necessarily related. For example, while the fan may have made her beer run at the same time and in the same stadium that the pitched ball left Zambrano's hand, we would be hard-pressed to say that the one event had anything to do with the other. We can, of course, imagine a possible world in which the two events are related—in the case, say, of a fan who always makes a beer run when Zambrano is on the mound—but even in that case, the two events would not be related in the particular hierarchy of game-related events depicted in (14). Indeed, it is not even the case that all of an actor's own actions are relevant to some given event that he has initiated. If Zambrano, a right-handed pitcher, wiggles the thumb of his left hand just before he releases the ball from his right, for example, we would not assume that the wiggling event was related to his pitch.

To get a little more specific, so far, the relationships between most of the events under discussion—Zambrano's pitch, the batter's hit, and even Booth's killing of Lincoln—and their subevents has been one of <u>causation</u>. For now, I would like to define a causative event as one in which some agent X performs an action that causes some change of state in another entity Y. (This is, perhaps, an oversimplified view of causation on many accounts, but it will serve our immediate purposes.) Imagine, for example, an event in which a girl makes a ball bounce up and down by hitting it repeatedly with her hand—the girl is *dribbling* the ball. Previous work on the conceptual (e.g., Leslie 1984a, Leslie & Keeble 1987) and linguistic (e.g., Carter 1976, Dowty 1979, Jackendoff 1990, Levin & Rappaport Hovav 1995, Talmy 1985) representation of events (which I will outline in detail in this chapter and the next) has shown that we represent causative events as consisting of three distinct subparts, which I will refer to as the MEANS, the CAUSE, and the RESULT.

(15)



The subevent *X acts* in (15) specifies the MEANS or causing subevent—the action of agent X, and the subevent *Y becomes state* specifies the RESULT subevent—the change of state in entity Y. In the case of our dribbling girl, the means action is the girl's hitting of the ball, and the result is the ball's bouncing. The intervening subpart CAUSE represents the nature of the relationship that links the other two subevents to each other: i.e., that agent X's activity is responsible for inducing the change of state in entity Y. In the case of the dribbling girl, this represents our understanding that the girl's hitting of the ball directly results in the ball's change of state.

The subevents associated with causative events in the kind of partonomic structure depicted in (13) and (14), then, provide more details about the means action(s) and the resulting change(s) of state associated with these events. In the case of Booth's killing of Lincoln, Booth's shooting of Lincoln is the action that causes the killing, and Lincoln's death is the resulting change of state. Likewise, in the case of the batter's hit, we understand that the batter's swing (ending in contact between the bat and the ball) is the means (sub)event and the ball's pop fly ball (characterized by movement of the ball very high and toward the outfield) is the resulting change of state. The remainder of this chapter will be devoted to a more detailed discussion of the experimental evidence demonstrating that we actually represent events with this kind of internal structure.

2.2 Psychological Salience of Event Structure

It is well established that the sets of percepts that humans perceive as coherent bounded whole objects are individuated, usually automatically, from within a given scene on the basis of properties such as spatial arrangement and orientation, size, color, texture, function, and path of motion (e.g., Carey & Xu 2001, Marr & Nishihara 1978, Spelke 1990, Xu et al. 1999). There is evidence, moreover, that in addition to perceiving physical objects as coherent wholes, infants and adults understand them to be comprised of an assemblage of hierarchically related parts. Exactly which bits of an object are considered to be parts of that object is determined on the basis of both perceptual and conceptual factors: i.e., different parts of objects have different shapes and serve different functions. A list of the parts of a car, for example, might include wheels, steering wheel, engine, seats, windows, and doors, all of which affect both the object's appearance and its performance. Experimental studies on object representation show that we use information about parts to identify and categorize objects (Marr & Nishihara 1978, Rakison & Butterworth 1998, Tversky 1989) and to make predictions about form-function correspondences (Madole & Cohen 1995, Tversky 1989, Zacks & Tversky 2001).

Likewise, there is a growing body of research demonstrating that, from infancy, we encode the ongoing activity of the world as events with internal structure, such that the set of multiple events that correspond to one temporally bounded happening are hierarchically related, with complex events comprised of many (potentially complex) subevents. Experimental evidence reveals that these complex structures affect our on-line perception of events and have implications for higher-level cognitive processes, including the comprehension and recall of events and event narratives and the association of event representations with linguistic forms.

Using a procedure first developed by Newtson and colleagues (Newtson 1973), Zacks et al. (2001) presented adult participants with videos of actors engaged in everyday activities (e.g., making the bed or assembling a saxophone) and asked them to tap the space bar on a computer keyboard when they judged one unit of a given activity to have ended and another to have begun. Each participant saw the videos twice, and was instructed on one viewing to mark boundaries at the smallest meaningful units (fine-grained coding) and on the other to mark boundaries at the largest meaningful units (coarse-grained coding). What they found was that, across participants, the location of unit boundaries marked in the fine-grained coding condition for any given activity corresponded significantly with the location of boundaries marked in the coarse-grained coding condition, such that several small units were marked during the activity associated with any one large unit, one of which began roughly at the beginning of the large unit, and another of which ended with the large unit. A subset of the participants were also asked to provide descriptions of the units they marked, and these descriptions demonstrate that in many cases the small units marked by participants represented coherent parts of the large units: e.g., the small units "taking off the blanket," "pulling the pillow out of the case," "dropping the pillow," and "taking out the sheet" were marked during the portion of the bed-making activity that corresponded to the large unit "taking apart the bed." The results of this on-line task demonstrate, then, that adults encode ongoing activity in terms of partonomic hierarchies. The question remains, however, what criteria these adults were using to segment units from within the ongoing activity.

One answer comes from a similar study in which Newtson (1973) coded the motions of the actors in his videos using dance notation, which allowed him to monitor changes in their body position. A comparison of this data to that collected in an on-line segmentation task revealed that the boundaries that his participants marked between units of ongoing activity corresponded to maximal changes in physical features of the activity. In a series of studies using these same videos, Newtson & Engquist 1976 found that adult participants demonstrated sensitivity to the same unit boundaries in a variety of perceptual and conceptual tasks: deletions of frames from the videos were better detected when they were taken from unit boundaries; descriptions of events were more accurate when participants were presented with unit boundaries than when they were not; and memory for short clips of the videos that included unit boundaries was better than for those that did not. Newtson & Engquist concluded that these findings were due to the increased discriminability of activity at unit boundaries.

More recent studies show, moreover, that this ability to define action boundaries on the basis of salient spatiotemporal features is not limited to adults. Sharon & Wynn (1998) demonstrate in a series of habituation studies that by 6 months of age, children can individuate short heterogeneous sequences of actions performed by a puppet (e.g., the puppet falls, then jumps, then falls) only when the different actions are separated by spatiotemporal discontinuities. Their infants failed to individuate heterogeneous actions, however, when they were presented as a continuous stream of motion.

In addition to these perceptual cues, there is evidence that the processing of events may be guided by top-down influences, most notably by conceptual expectations based on prior experience with a particular kind of event. Different events may be more or less constrained by physical laws or by social convention. Compare, for example, the highly organized structure of a baseball game with the more chaotic situation of children playing on a playground. A group of people hitting baseballs with bats is not really playing a baseball game unless they form into two teams and establish four bases and play for nine innings, etc. On the other hand, it is generally the case that any child who goes down a slide or swings or crosses the monkey bars may be described as having been playing on the playground.

Increased experience with a given kind of event may provide a better understanding of its rules or of the variant and invariant parts of the routine associated with it, which may in turn, lead to a more complex representation of the partonomic hierarchies with which it is associated. Slackman et al. (1986) describe a group of school children whose description of their school day routine becomes more detailed and increases in structural complexity between the first and the eighth weeks of school. Fivush et al. (1992) demonstrate that children encode more elaborate and more complex event representations and exhibit better recall for subevents when they are more familiar with the structure of a given activity. And the Zacks et al. (2001) study described above suggests that even adults may benefit from experience: their participants encoded familiar events like making a bed with more complex structures (i.e., with more small units per large unit) than unfamiliar events like assembling a saxophone.

In light of the role of proscribed event structures in representation, furthermore, it is important to note that in the experiments that I have been describing so far, participants are almost always presented with clearly defined sets of actions to segment and describe. They are not asked, for example, to segment all of the overlapping action going on in a symphony hall before a performance into natural and meaningful units, but rather to deal with a clearly defined goal-directed subset of that activity, like a single saxophone player assembling her instrument. As we are aware, however, activity in the world is not so neatly demarcated, and so the nature of the stimuli presented in these experiments itself imposes constraints on the way that observers will perceive event structure. It seems logical to ask, then, whether these clearly defined sets of actions actually reflect the way that observers carve up the world, i.e., to determine what organizing principles guide the associations between the event representations in a given partonomic hierarchy.

One of the organizing principles that has been identified as significant for event parsing is intentional action: habituation studies show that infants as young as 6 months of age encode activity in terms of actions that are performed with the goal of bringing about some change of state in the world. Baldwin et al. (2001) demonstrate, for example, that 10–month-old children who are familiarized to sequences of continuous everyday activity dishabituate to versions of the sequences in which the activity is paused in the middle of an actor's pursuit of intentions, but not when the pause occurs at boundaries between intentional actions. Woodward & Sommerville (2000) show that spatiotemporal features of an event play a role in whether 12–month-old children encode it as intentional: their participants associated a noncausal action (touching a box) with an intentional action (grasping a toy in the same box) only when the two occurred in temporal sequence. Woodward (1998) finds this sensitivity to intentionality in effect by 6 months of age. Taken together, moreover, the results of her studies suggest that infants interpret events in terms of means-end sequences, and that in the representation of intentional actions, achievement of the actor's objective is more important than the means by which it is achieved. Interestingly, children seem to assume that events are defined by intentionality even when presented with actions in which the actor's objectives are not realized (Meltzoff 1995). And the assumptions that children make about intentionality do not seem to be restricted to human actors: Csibra et al.

(2003) find similar results in 12-month-olds using computer animations of events in which one ball chases another ball around the screen.

Causality is another of the organizing principles that we use to define event boundaries. Michotte (1946/1963) investigated the perception of causality in adults in a series of classic studies in which he presented participants with a dynamic visual display of what appeared to be two rectangles, one black and one red. In the basic version of his event, the black rectangle moves along a linear path and at a constant speed toward the red rectangle, and when they come into contact, the black rectangle stops and the red rectangle moves away in the same direction at a constant speed. Upon viewing this sequence, Michotte's participants described it as a "launching event" (p. 20) involving a transfer of motion between the two rectangles, such that the blow provided by the black rectangle causes the movement of the red rectangle.

The results of Michotte's studies led him to conclude that that the perception of mechanical causation is automatic and instantaneous, driven by changes to simple perceptual features like temporal and spatial contiguity and the distribution of motion across entities in an event (see also White 1988, Zacks & Tversky 2001). Recent work suggests that the perception of causality may also be affected by things like the perceptual context of an event (Scholl & Nakayama 2002) or the intentionality of an animate agent (Leslie 1984a, Wolff 2003, Wolff & Gentner 1996), but Michotte's original hypothesis that the perception of simple mechanical causality involving two inanimate entities is rooted in the perceptual system still holds water. Indeed, an fMRI study of adults watching simple launching events confirms that the perception of simple mechanical causality is automatically processed by areas of the cortex specialized for low-level processing of visual motion (Blakemore et al. 2001).

Given this perceptual basis, it should not be surprising to learn that infants appear to have access to the same kinds of complex representations for causative events that adults do. There is a growing body of literature in cognitive psychology demonstrating that at as young as 2.5 months of age, children are sensitive to various components of causality, including spatiotemporal continuity of motion and contact between event participants. Spelke et al. (1992), for example, provide evidence that infants notice differences between events that are possible and impossible with respect to continuity of motion: their results show that if infants expect the motion of a ball to have been blocked by some obstacle in its path, they demonstrate surprise when it appears not to have been. Leslie (1982, 1984b) has obtained similar results in 4.5–month-old infants habituated to films that replicate Michotte's simple launching events. His results demonstrate that these infants dishabituate when presented with similar but discontinuous events, i.e., if the two colliding bricks don't make contact or if there is a lag in time between that contact and the displacement of the second brick.

By pitting these direct launching events against a similar event in which a single brick moves across the entire screen (changing in color from red to green halfway across), Leslie (1984b) provides evidence, moreover, that 7.5–month-old infants perceive the direct launching event as having internal structure. Infants habituated to the direct launching sequence demonstrated stronger dishabituation when presented at test with a reversal of the habituation sequence (i.e., green brick hits red brick) than did infants habituated to the single-block movement, indicating that they perceived the direct launching sequence as being made up of multiple temporally ordered subevents rather than as an unanalyzed single movement. To further investigate the nature of this internal structure, Leslie & Keeble (1987) performed a follow-up study in which they compared reversal of a direct launching event with reversal of a perceptually similar but noncausal event (direct launching with delayed displacement of the second block). Their results showed that infants tested on the direct launching event displayed more dishabituation than did infants tested on the non-causal event, suggesting that the comprehension of direct launching by these infants involved more than just an encoding of its spatiotemporal properties—perhaps also (or instead) involving an encoding of a causal relationship between the entities involved in the event.

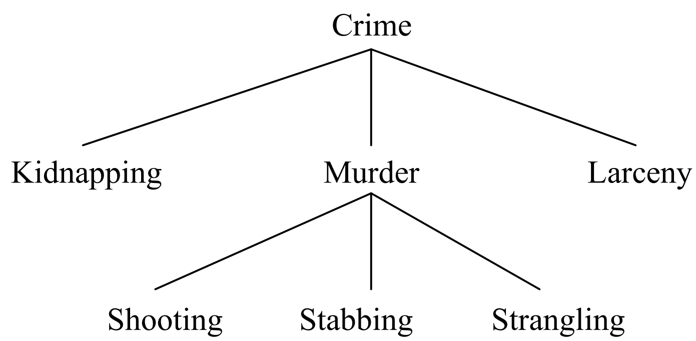
We have evidence, then, that infants, like adults, are able to represent causative events as being composed of multiple subevents related by the idea that an agent's action is somehow transferred to another entity, causing the second entity to undergo some change of state or location. Previous work has suggested that the effect in a causal relationship is most closely associated with the agent (e.g., Casasola & Cohen 2000, Cohen & Oakes 1993, Michotte 1946/1963). Cohen and Oakes (1993) demonstrate, for example, when that 10-month-olds are habituated simultaneously to an entity X initiating a causal launching sequence and an entity Y initiating a noncausal delayed launching sequence, they dishabituate to changes to the agents, i.e., when Y initiates the causal event and X the noncausal event. However, when habituated to a causal sequence in which X launches a second entity A and a delayed launching sequence in which X moves first and a second entity B moves second, they do not dishabituate when the second entities are switched. These results suggest that the perception of causality is more closely tied to the agent's action (or the means subevent) than to the result of the event.

We have demonstrated, however, that the change of state undergone by the patient of a causative event can also be made salient (Bunger & Lidz 2004). In a preferential looking study, we asked 2-year-olds to extend the meaning of a novel verb associated with a causative event (e.g., a girl dribbling a ball) to refer either to the MEANS or the RESULT subevent of the complex causative. What we found was that children who heard the novel verb in an unaccusative intransitive sentence like “The ball is pimming” were more likely to interpret it as a label for the result subevent—a bouncing ball—than for the means subevent—the girl patting a ball that does not bounce. Note that if our 2-year-olds didn’t represent causative events as having internal structure, they would not have been able to arrive at this interpretation of the novel verb: i.e., if their representations of these causative events didn't include a RESULT subpart, then they wouldn't have been able to tease that subevent apart from the whole event.

2.3 Discussion

In this chapter, I have summarized the current state of our understanding of the nature of conceptual event representations. Note, however, that the partonomies that I’ve been describing are not the only way that events can be related: events may also be related taxonomically (Rosch et al. 1976). Objects and events are organized in taxonomic categories according to a kind-of relationship between their members, and levels of categorization are defined in terms of their inclusiveness and their abstraction: higher-level categories are both more general and more abstract; lower level categories tend to be more specific and more concrete (Lucariello & Rifkin 1986). We may refer to the same piece of sporting equipment, say, with a superordinate-level category label like *sports equipment*, with a basic-level label like *ball*, or with a subordinate-level label like *baseball*. Likewise, we may refer to a particular event with a superordinate-level descriptor like *crime*, a basic-level descriptor like *murder*, or a subordinate-level descriptor like *shooting* (16; adapted from Rifkin 1985).

(16)



Taxonomic categories are organized on the basis of shared sets of features. Tversky & Hemenway (1984) argue that for categories of objects, the members of a superordinate category share functions and the members of basic-level and subordinate categories share parts. Indeed, it is these shared clusters of parts that are responsible for the natural breaks among categories at the basic level. Likewise, taxonomic categories of events are linked by correlations among event features (e.g., state of change, path of motion) (Kersten & Billman 1997, Rifkin 1985, Rosch et al. 1976). The hierarchical nature of taxonomies allows inference from higher-level to lower-level categories: an attribute that holds of a crime (e.g., that it is punishable by law) is true of the basic-level event categories kidnapping, murder, and larceny; likewise an attribute that holds of murder (e.g., that it involves a killing) is true of the subordinate event categories shooting, stabbing, and strangling.

It is well established, moreover, that for objects, the basic level of categorization is favored by both adults and children for a variety of cognitive tasks (e.g., Graham et al. 1998, Waxman 1990), and recent studies suggest that the same is true of events (Lucariello & Rifkin 1986, Morris & Murphy 1990, Rifkin 1985, Rosch et al. 1976, Tversky & Hemenway 1984, Zacks & Tversky 2001). Morris & Murphy (1990) demonstrate, for example, that the basic level is primary for the categorization and naming of events: they report that adults tend to choose basic-level terms to name related sets of actions and are fastest at associating actions with event categories when the categories are named at the basic level. They argue, furthermore, that labeling objects and events at the basic level is optimally informative in that it maximizes both the inclusiveness and the informativeness of the descriptor: labels at the superordinate level are often not specific enough to be informative (What kind of *crime* did Booth commit?), and descriptions at the subordinate level often do not provide any additional relevant detail. Not surprisingly, the primacy of labels that pick out basic level categories has implications for word learning: Tversky & Hemenway (1984) point out that that mutual exclusion of object labels applies at the basic level—as they put it, "something isn't both a cantaloupe and a ball" (p. 188)—and it is likely that the same is true for event labels.

One question that I have intentionally left open is where our event representations come from, i.e., whether they reflect an inherent conceptual bias to carve up the world in terms of causality or intentionality or rather a perceptual bias for certain relationships between entities, perhaps based on an ongoing computation of observed regularities across activities in the world (e.g., Cohen et al. 2002). Research on infants' understanding of the physical world suggests that we enter the world preprogrammed with sensitivity to at least some relationships between physical entities, e.g., individuation, occlusion, support, containment, contact, continuity of motion (e.g., Baillargeon 1998, Spelke 1994). Indeed, neuroimaging techniques provide evidence that the perception of simple mechanical causation is automatic and instantaneous, and infants as young as 3 months can distinguish a launching event from an event in which either temporal or spatial continuity of motion is violated. Even in preschoolers, however, the perception of causality can also be affected by conceptual information like intentionality, and with development, we gain the ability to apply more controlled forms of causal processing (White 1988). Adults will accept as causally related events that are abstract or that are displaced from one another in time and/or space, e.g., that the murder of Archduke Franz Ferdinand in Sarajevo on June 28, 1914 caused World War I, which began with a declaration of war in Austria-Hungary on July 28. It is likely to be the case, then, that our event representations are built on the basis of both inherent (perceptual or conceptual) biases and world knowledge gathered from experience: infants may start with event representations based on automatic perception of physical cues, but eventually they abstract general principles that they can apply to less concrete sequences of events.

Regardless of what the origins of our event representations are, recent work suggests that there is a direct correspondence between the way that we conceptualize events and the way that we can talk about them. Lakusta & Landau (2005) demonstrate, for example, that the general preference for goals or endpoints of action over sources of action that has been found for a variety of events (e.g., Leslie & Keeble 1987, Meltzoff 1995, Woodward 1998) is reflected in the way that we describe similar kinds of events. Their results show that both children and adults describing events that involve either motion directed toward a particular goal, transfer of possession, change of state, or attachment or detachment of entities from surfaces included goals in their event descriptions (encoded either in verbs or in prepositional phrases) both more often and more accurately than they included sources.

Along the same lines, Wolff suggests that the force dynamics of a given event affect the way we label it (Talmy 1985, Wolff 2003). In support of this hypothesis, he offers results from a series of studies demonstrating that adults presented with a simple sequence in which one marble launches another marble are more likely both to conceptualize the sequence as a single event and to describe it using a lexical (single-verb) causative construction rather than a periphrastic (clausal) causative construction than they are a launch that is part of a causal sequence mediated by a third marble. Inferred intentionality on the part of the entity that initiates the launch sequence (e.g., if it is a hand rather than a marble) increases both of these tendencies even more (Wolff 2003, Wolff & Gentner 1996).[9]

Wagner & Carey (2003) demonstrate, moreover, that the way that an event is described can affect the way that preschoolers and adults conceptualize it. They presented participants with videos consisting of either one or two instances of a single goal-directed activity (e.g., a girl painting a flower), and asked them to count the number of times some specified event happened. What they found was that participants were more likely to individuate events when they were described with a telic predicate, i.e., one that specified an endpoint, like “paint a flower,” than when the same sequence was described with an atelic predicate like “paint.” These results suggest that not only can the way that events are conceptualized affect the way they can be described, but also that the way that events are described can affect their construal.

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[9] See also Lidz et al. 2003 for a discussion of the use of lexical and periphrastic causatives in the Dravidian language Kannada.

Theorists in a range of disciplines have suggested, moreover, that very early event representations may encode features that map directly onto linguistic structures, providing representations available for lexicalization (e.g., Mandler 1992).[10] Studies in young language learners have revealed that children are sensitive to some of the more transparent mappings between conceptual and linguistic event representations: e.g., the relationships between early conceptualizations of containment and support and the English prepositions *in* and *on* (Bowerman 1989), between Korean verb classes and the notions of self-motion and caused motion (Choi & Bowerman 1992), and between the actors and entities relevant to an event and linguistic argument structure (Slobin 1985).

Gordon has been investigating this last relationship in a series of what are being called “change blindness” studies (e.g., Gordon 2004). In these experiments, Gordon habituates infants to a video of actors performing some action, then shows them new videos in which one of the entities present in the habituation video is missing. In one study, infants were habituated either to a video of a girl giving a stuffed camel to a boy or to a video of a girl hugging a boy while holding a stuffed camel. At test, infants in each group were shown videos of events that were identical to the habituation events except for the presence of the stuffed camel, which was now missing. His 10–month-old participants noticed the absence of the stuffed camel (indicated by longer looking times at test) only when they had been habituated to the *giving* event; infants habituated to the *hugging* event did not dishabituate when the camel was removed. Note that the camel is a relevant participant only in the transfer of possession event; a linguistic description of this kind of event minimally requires a giver, a receiver, and a thing that is given (17a).

[10] This conceptual knowledge may also provide a foundation for the development of home sign systems by deaf children not exposed to a conventional language, e.g., Goldin-Meadow 1985, Goldin-Meadow & Mylander 1993.

(17) a. The girl gave the boy the camel.

b. The girl hugged the boy.

In the hugging event, a description of which minimally requires only a hugger and a hugee (or two huggers, in the case of a reflexive predicate) (17b), the camel is incidental. Thus, Gordon's studies suggest that (at least some of) the features of events that are relevant for prelinguistic event representation are the same as those that are relevant for linguistic structure. In the next two chapters, I will discuss in more detail how our event representations are related to our linguistic representations of events, and what the implications of that mapping are for the acquisition of single-word labels for events, viz., verbs.

Chapter 3

Linguistic Representations

It is widely accepted that the meanings that we assign to expressions in any given language are linked inextricably with our conceptual representations. For example, Talmy's (1985) theory of force dynamics, which is proposed to underlie our understanding and description of causal relationships, is based on the assumption that "conceptual models of certain physical and psychological aspects of the world are built into the semantic structure of language" (p. 329). Levin & Rappaport Hovav (1995) point out, furthermore, that "in general, the relation between the linguistic description of events and the events taking place in the real world is mediated by the human cognitive construal of events, which is what we take our lexical semantic representations to represent" (p. 98). Jackendoff (1990) goes so far as to define the idea of a concept entirely in terms of its usefulness to language, as "a mental representation that can serve as the meaning of a linguistic expression" (p. 11). It has been demonstrated, furthermore, that this grounding of linguistic expression in conceptual structure has significant implications for the structure of languages.

The simplest way to map events onto linguistic expressions is to encode them as single verbs. Verbs provide labels for categories of actions or states. Their representations are composed of paired-down sets of essential features abstracted from across instances of a particular category of events unified, e.g., by a particular kind of motion (*bounce*, *roll*), contact (*hit*, *touch*), creation (*build*, *write*), consumption (*eat*, *chew*), transfer of possession (*give*, *buy*), or caused change of state (*break*, *kill*). The participants in a given event are encoded as arguments specified by the verb, and the verb itself may be understood as encoding the relationship that those arguments hold to one another. Indeed, many of the features that have been identified as important for individuating events, e.g., spatiotemporal continuity and contact between event participants, as well as the partonomic relationships that hold between events, turn out to be important for encoding events as single verbs (e.g., Carter 1967; Gruber 1965; Jackendoff 1983, 1990; Krifka 1998; Levin 1993; Pustejovsky 1991; Talmy 1985; Tenny 2000). The goal of this chapter is to discuss some of the things that we know when we know a verb, including what kinds of things a single verb can label, and how that meaning is represented in linguistic structure. In the course of the discussion, we will find that not every set of activities in the world can be mapped to a single verb; to account for these gaps, I will discuss some of the conceptual and linguistic constraints on what verbs can mean.

3.1 Regular Mapping Between Verb Meaning and Verb Behavior

Numerous researchers have uncovered regular mappings between event representations and aspects of sentence structure (Baker 1988, 1997; Carter 1967; Gruber 1965; Jackendoff 1972, 1983, 1990; Levin 1993; Pinker 1989). At a very basic level, one thing that this mapping gives us is the understanding that the number of arguments included in an event description accurately reflects the number of participants included in the corresponding event representation.[11] We understand, for example, that an event labeled by the verb *laugh* requires the involvement of

[11] See Williams 2005 for some exceptions to this generalization, viz., events like *strike out*, *jimmy*, and *pry*, which involve requisite participants or instruments that are never specified as arguments, and Rappaport Hovav & Levin 1998 for a method of dealing with these exceptions in lexical semantic representations.

only one participant, the laugher, who acts in some particular manner (i.e., she laughs). The semantic representation for this kind of simple activity would consist of something like (18a), in which a single event participant X is specified as the entity engaged in some activity. This kind of event description, underspecified as it is for semantic content, is typically referred to as a "lexical conceptual structure" because it encodes only the conceptual information about a given event that is relevant to the lexicon-syntax interface (i.e., for grammatical structure or operations). The semantic primitive ACT is used here as a placeholder for the specific activity that the agent engages in because in this case the particular manner of the activity is not relevant to the grammar. If we wanted to describe a particular instance of this kind of event, we could map this event representation onto the event description in (18b), in which the event participant X is identified with the entity Lane and the feature ACT is identified as an event of laughing. However, we might just as easily identify the activity represented in (18a) as *crying*, as in (18c).

(18) a. [X ACT]

b. Lane laughed.

c. Lane cried

Similarly, we understand that an event of consumption describes a relationship between two participants—the consumer and the consumed—and so the corresponding event representation must include two unspecified participants, as in (19a).[12] To describe a particular instance of consumption, we could map this event representation onto the event description in (19b), in

[12] The event representation in (19a) has been simplified for expository purposes. See (26) for an elaboration.

which the consumer X is identified as Lorelai, the consumed Y as coffee, and the consumption event as one of drinking.

(19) a. [X CONSUME Y]

b. Lorelai drank coffee.

Part of what we know when we know a verb, then, is the number and type of arguments that that verb takes, how those arguments map onto syntactic structures, and the range of syntactic structures in which that verb can occur. It has been argued, furthermore, that these relationships between verb meaning and verb syntax rely on fixed mapping rules (e.g., Baker 1997, Levin 1993, Pietroski 2005, Pinker 1989).[13]

Levin (1993; building on the work of Carter 1976, Gruber 1965, Jackendoff 1990, etc.) provides support for the claim that the meaning of a word determines its syntactic behavior by demonstrating that verbs fall into distinct subclasses on the basis of shared components of meaning that constrain syntactic behavior. Interestingly, some of the features that have been found to be central to the conceptual representation of events have also been shown to have implications for the syntactic behavior of verbs expressing those features. Contact between event participants is one of these influential components of verb meaning: note that only verbs that

[13] Baker (1988, 1997), for example, provides crosslinguistic evidence that identical thematic relationships between entities at the level of conceptual structure are represented by identical structural relationships between those entities in the syntax (see also Perlmutter & Postal 1984). According to this hypothesis, then, if something is acting as an agent or causer in an event, that thing will be syntactically realized as a subject, whereas if something is acting as a patient—the entity affected by the event effected by the agent—it will be syntactically realized as an object. Snedeker & Gleitman (2004) argue, moreover, that these relations between syntactic arguments and semantic roles are part of the set of preprogrammed assumptions that children bring to the task of language learning. (See Grimshaw 1990, Jackendoff 1990, Levin & Rappaport Hovav 1995, Rappaport Hovav & Levin 1998, and Wunderlich 1997 for alternative approaches to the linking of event participants to semantic roles.)

necessarily encode contact between the event participants may participate in the so-called Body-Part Possessor Ascension Alternation, as illustrated in (20) and (21):

(20) a. Luke cut Kirk's arm.

b. Luke cut Kirk on the arm.

(21) a. Miss Patty broke Taylor's finger.

b. * Miss Patty broke Taylor on the finger.

An event of cutting necessarily involves contact between the instrument used to do the cutting and the thing that gets cut, and so it may occur in both of the syntactic frames in (20). Because an event of breaking does not necessarily involve contact (as in the case of a glass broken by an opera singer's voice), however, it is barred from participation in this alternation. Note, furthermore, that these are not isolated cases—there is a whole set of verbs that pattern like *cut* with respect to this alternation, all of which describe events that necessarily involve contact, e.g., *scrape*, *saw*, *scratch*; and there is another set of verbs that pattern like *break*, none of which describe events that necessarily involve contact, e.g., *crush*, *shatter*, *split*.

Another conceptual feature that has significant implications for the expression of verbs is the notion of causality. Building on Talmy's (1985) proposal, Jackendoff (1990) outlines how a conceptual organizing system based on the dynamics of force interactions (on a physical or metaphysical level) can account for the syntactic behavior of verbs that express various interactions between entities, including events that involve some form of successful or unsuccessful causation. The sentences in (22) illustrate the so-called Causative/Inchoative Alternation (Hall 1965, Levin 1993, etc.). Note that the verb *bounce* can be used both in a transitive frame, as in (22a), and in an unaccusative intransitive frame, as in (22b), in which the object of the transitive sentence appears as the subject of the intransitive. In this alternation, the object of the transitive verb and the subject of the intransitive verb share the same semantic role: in both cases it is the ball that is affected in the event—it bounces—and in (22a) it is Michael Jordon who somehow causes that bouncing.

(22) a. Michael Jordon bounced the ball.

b. The ball bounced.

As with the Body-Part Possessor Ascension Alternation, verbs that can participate in the Causative/Inchoative Alternation share certain elements of meaning. First, these verbs must describe events that are internally complex: here, Michael Jordon performs some action, and this action causes a change of state in the ball. Crucially, furthermore, verbs that can occur in this alternation must label the object's change of state: in this case, it's the ball that bounces, not Michael. Other verbs that can participate in this alternation include *spin* and *roll*.

The verb *hit*, however, cannot participate in this alternation:

(23) a. Sammy Sosa hit the ball.

b. * The ball hit.

Although *hit* can be used in a transitive sentence, as in (23a), the corresponding unaccusative intransitive sentence is ungrammatical (23b). Note that an event of hitting does not entail that the thing hit undergoes a change of state: this is why we can make observations like that in (24):

(24) Logan hit the curb while parking his car, but the curb wasn't affected.

Thus, the ungrammaticality of (23b) is due to the fact that the verb *hit* doesn't label some change of state undergone by the ball: it's Sammy that *hits*, not the ball.[14]

When we encounter an event in the world like a causative that corresponds to a complex conceptual structure, we need not specify all of the (sub)parts of that event in our descriptions of it. Indeed, one kind of linguistic support for the kind of internally complex conceptual structure discussed in Chapter 2 comes from the fact that we can use different classes of verbs to describe the different specific subparts of a causative event. Imagine, for example, an event in which a baseball player bunts a ball, as in (25):

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[14] This is not to say that events described with the verb *hit* are not generally causative. Certainly, Sammy's *hitting to Wisconsin* or *hitting a home run* in this recap of a 2000 Cubs-White Sox game describe potential events in which Sammy's contact with the ball successfully results in a change of the ball's motion and location (underlines mine):

(i) Sosa wound up with five strikeouts, trying to hit the ball to Wisconsin with every swing. "His swing appeared to be long and kind of tight," Baylor said. "Yeah, it appeared he wanted to show he could hit a home run in some of those at-bats."

(Retrieved May 16, 2006, from http://chicagosports.chicagotribune.com/sports/baseball/whitesox/cs000609soxcubs,1,4068135.story?coll=cswhitesox-navigation)

The point to be made, however, is that our understanding that some causation has taken place in these cases is not due to some event feature encoded by the verb *hit*, but rather to an inference that we make on the basis of cues from other elements of the verb phrase (e.g., "to Wisconsin") combined with our knowledge of how bats and balls generally interact in a baseball game (i.e., once a ball is hit, it usually moves).

(25) Maddux then bunted the ball right back at Oswalt to start a double play before Corey Patterson's RBI double made it 3-2.[15]

In a *bunting* event, a batter uses a bat to lightly tap a pitched baseball a short distance across the field without actually swinging the bat.[16]

Rappaport Hovav & Levin (1998) propose that there exists a fixed set of event structure templates that correspond directly to the aspectual verb classes first outlined by Vendler (1967; see also Dowty 1979). In their system, a verb labeling an accomplishment, like *bunt* (or *drink* or causative *bounce*), would be represented with the complex structure in (26):

(26) [[X ACT] CAUSE [BECOME [Y <STATE>]]]

In this type of event, some agent X performs some specific action that causes Y to be in some specific state. This representation can easily be correlated with the parts of a causative event as described in Chapter 2: using this structure, we can identify the subparts of a causative *bunting* event like that described in (25) as in (27):

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[15] Retrieved April 19, 2006, from http://sports.yahoo.com/mlb/recap?gid=251002118

[16] Definitions of *bunting*:

> "[One way to advance a runner while sacrificing a base hit is to] simply hold the bat out toward a pitch rather than swing the bat, so that when the ball is hit, it rolls slowly toward the infield" (MSN Encarta, retrieved May 15, 2006, from http://encarta.msn.com/encyclopedia_761577710_2/Baseball.html).

> "In a bunt play, the batter loosely holds the bat in front of the plate and intentionally taps the ball into play … The bunt is often characterized by the batter turning his body toward the pitcher and sliding one hand up the barrel of the bat to help steady it" (Wikipedia, retrieved May 15, 2006, from http://www.answers.com/topic/bunt-1?method=5).

(27) $[[\underbrace{\text{Maddux taps ball with bat]}}_{\text{MEANS}}\ \text{CAUSE}\ [\underbrace{\text{BECOME [characteristic movement of ball]}}_{\text{RESULT}}]]]$

Here, the activity of the baseball player—the light tapping of the ball with the bat—represents the means subevent of the complex causative [X ACT], and the resulting movement of the ball—flying through the air, bouncing or rolling across the field—represents the result subevent [BECOME [Y <STATE>]]. The evaluation of the *bunting* event as causative comes from our understanding that the baseball player's activity was directly responsible for the movement of the ball.

If we wanted to be maximally informative in our description of this *bunting* event, we could choose a verb that encodes all three of the subparts of the complex causative, as in (28):

(28) Maddux bunted the ball.

Included in the meaning of *bunt* are the activity engaged in by the agent Maddux (the tapping of the ball with the bat), the resulting characteristic movement of the ball (the rolling or bouncing), and the causal relationship between these two subevents. This is not the only option we have for describing a complex event, however. We may choose instead to describe just the activity of the baseball player, using a verb that specifies only the means subevent, as in (29), or we may choose to describe just the movement of the ball, using a verb that specifies only the result subevent, as in (30).

(29) a. Maddux turned.

b. Maddux held the bat.

c. Maddux tapped the ball.

(30) a. The ball bounced.

b. The ball rolled.

Note that none of the sentences in (29) entail that Maddux actually caused any change of state in the world. The manner verb *turn* labels an activity that Maddux engages in that is independent of his relationship to the other entities involved in the event. And while the verb *hold* labels the extended contact that Maddux makes with the bat and *tap* labels the contact that he makes with the ball, in each case the effect of his activity on the object is left unspecified (Levin 1993): this is why it is acceptable to say something like "Maddux tapped the ball, but it didn't move."

Both of the verbs in (30) label manners of motion that are characteristic of inanimate entities with no entailment of protagonist control over the event (Levin 1993), i.e., balls can bounce and roll even if there is no one there to tap them. Thus, while the unaccusative sentences in (30) do describe the movement of the ball in the bunting event, neither provides details about how or even whether this movement was caused by some external agent.

It is also possible to describe this event by making reference only to the act of causation that occurs, specifying neither the means by which it was effected nor its result:

(31) a. Maddux caused a change.

b. Maddux affected the ball.

The sentences in (31) describe a causal event in which Maddux acts as an agent. However, both the result of this causal relationship (e.g., a change in the location of the ball) and the means by which it was brought about are left unspecified. In (31a), even the entity that Maddux affects is unspecified.

In addition to these individual subparts, furthermore, we may also choose to lexicalize certain combinations of the subparts of a causative event.

(32) Maddux moved the ball.

For example, a result verb[17] like *move* in (32) encodes both the change in the affected entity (here, a change in the motion or location of the ball) and the notion that this change was directly caused by some external agent (in this case, the subject of the transitive sentence), but it leaves unspecified the means by which that change was brought about. The sentence in (32) may thus rephrased without contradiction as in (33), in which the unidentified nature of the causing activity is highlighted:

(33) Through an unspecified activity, Maddux caused some change in the location of the ball.

[17] The distinction between manner and result verbs comes from Rappaport Hovav & Levin 1998. See also Behrend 1990, Gentner 1978, and Gropen et al. 1991 for independent support from studies in child language acquisition.

Note that if the internal structure of the causative *bunting* event described in (25) was not psychologically real, we would not be able to understand that all of the options in (28)–(32) are possible descriptions of this same event. That is, if we couldn't individuate the subevents from the entire causative event and didn't recognize that one happening can correspond to many partonomically related events, we wouldn't be able to pick out the part(s) of the complex event structure being identified by these single verbs.

It is important to point out, furthermore, that when we describe a complex event using one of these verbs, our description actually entails each of the individual subevents encoded by that verb (e.g., Carter 1976, Parsons 1990, Pietroski 2000). So, for example, the transitive sentence in (34a), in which the verb *bounce* encodes both the change undergone by the ball and the fact that that change was caused by Michael Jordon, entails the unaccusative intransitive variant in (34b), in which the verb encodes just the result subevent: if Michael Jordon bounced the ball, then it must be the case that the ball bounced.

(34)	a. Michael Jordon bounced the ball.	CAUSE + RESULT
	b. The ball bounced.	RESULT

It is not necessary that the entailed situations be labeled by the same verb, as is the case with the causative and inchoative variants of *bounce*. Thus, the transitive sentence (35a) entails the unaccusative (35b): if Booth killed Lincoln, then it must be the case that Lincoln died.

(35) a. Booth killed Lincoln. CAUSE + RESULT

b. Lincoln died. RESULT

Not surprisingly, verbs that encode all of the subparts of a complex event entail all of those subparts. Thus, the transitive use of *bunt* in (36a) entails both the MEANS subevent of the causative (36b) and the RESULT subevent (36c): if Maddux bunted the ball, then he must have hit the ball and the ball must have moved in some characteristic way.

(36) a. Maddux bunted the ball. MEANS + CAUSE + RESULT

b. Maddux hit the ball (with the bat). MEANS

c. The ball moved. RESULT

The lexicalized combinations of subevents described above are common crosslinguistically (e.g., Harley 1996, Haspelmath 1993, Levin 1993, Levin & Rappaport Hovav 1995). The verbs in sentences (37)–(41) all label an activity that could potentially serve as the means of a causative event; the verbs in (42)–(46) label some change of state that may or may not have been caused by some external agent; the verbs in (47)–(51) label just some causal relationship between unspecified events; the verbs in (52)–(56) label causative events in which only the change of state is specified; and the verbs in (57)–(61) label causative events whose means and result subevents are both specified. Furthermore, by comparing the change of state verbs in (42)–(46) with the caused change of state verbs in (52)–(56) we can see that the

Causative/Inchoative Alternation described in (22) is a robust phenomenon across the world's languages.[18]

ACTIVITY (MEANS SUBEVENT)

(37) Sammy Sosa hit the ball. English

(38) Sammy Sosa a frappé la balle. French
Sammy Sosa have.3.SG hit the ball
'Sammy Sosa hit the ball.'

(39) ngaja nginuna palkan Dyirbal
I.NOM you.ACC hit-NFUT (Ritter & Rosen 2000: p. 224)
'I'm hitting you.'

(40) Zahra waxay taabatay balooniga Somali
Zahra she touch.MASC ball
'Zahra touched the ball.'

(41) Midaminun Annul tteriutta Korean
Midam.NOM Ann.ACC hit.PST.DC
'Midam hit Ann.'

CHANGE OF STATE (RESULT SUBEVENT)

(42) The ball bounced. English

(43) Ikkuna hajo-si Finnish
window.NOM broke-PAST (Pylkkänen 2002: p. 73)
'The window broke.'

[18] The reader should not be troubled by additional morphology on the causative verb forms. As we will see in Section 3.2, the causative variants of these verbs are associated with more complex linguistic representations than the simple change of state variants: in all of these cases, the additional morphology represents overt realization of that structure (viz., the semantic primitive CAUSE).

(44) baagil-u tere-d-itu — Kannada
door-NOM open-PST-3SN — (Lidz 1998: p. 39)
'The door opened.'

(45) Dharkii way qalaleen — Somali
clothes.PL is.PST dry.PL
'The clothes dried.'

(46) Yasai-ga kusa-tta — Japanese
vegetable-NOM rot-PAST — (Pylkkänen 2002: p. 73)
'The vegetable rotted.'

CAUSATION (CAUSE)

(47) Maddux caused a change. — English

(48) Jacques Chirac a effectué un changement. — French
Jacques Chirac have.3.SG cause a change
'Jacques Chirac caused a change.'

(49) Hildegard beeinflusste die Wahl — German
Hildegard influence.PST.3RD.SG the.ACC.FEM election
'Hildegard influenced the election.'

(50) Farah wuxuu sababay isbedel — Somali
Farah he cause.MASC change
'Farah caused a change.'

(51) Midaminun sesangul pakkuutta — Korean
Midam.NOM world.ACC change.PST.DC
'Midam changed the world.'

CAUSATION WITH SPECIFIED RESULT, UNSPECIFIED MEANS (CAUSE + RESULT)

(52) Michael Jordon bounced the ball. — English

(53) Liisa hajo-tti ikkuna-n — Finnish
Liisa.NOM break-CAUSE window-ACC — (Pylkkänen 2002: p. 73)
'Liisa broke the window.'

(54) gaaliy-u baagil-annu tere-d-itu — Kannada
wind-NOM door-ACC open-PST-3SN — (Lidz 1998: p. 39)
'The wind opened the door.'

(55) Abdi wuxuu qalajivey dharkii — Somali
Abdi he dry.MASC clothes.PL
'Abdi dried the clothes.'

(56) Taroo-ga yasai-o kus-ase-ta — Japanese
Taro-NOM vegetable-ACC rot-CAUSE-PAST — (Pylkkänen 2002: p. 73)
'Taro caused the vegetable to rot.'

CAUSATION WITH SPECIFIED MEANS AND RESULT (MEANS + CAUSE + RESULT)

(57) Maddux bunted the ball. — English

(58) Sabine dribbelte den Ball. — German
Sabine dribble.PST.3RD.SG the.ACC.MASC ball
'Sabine dribbled the ball.'

(59) Tiina heitti keihästä — Finnish
Tiina threw javelin-PART — (Ritter & Rosen 2000: p. 206)
'Tiina threw the javelin.'

(60) Ali wuxuu cabay caano geel — Somali
Ali he drink.pst.masc milk camel
'Ali drank camel milk.'

(61) Midaminun mekjurul masiutta — Korean
Midam.NOM beer.ACC drink.PST
'Midam drank beer.'

It is not the case, however, that any spatiotemporally related happenings in the world may be lexicalized as a single verb. Indeed, the mapping of verbs to happenings in the world appears to be subject to a constraint such that single verbs cannot encode sets of events that are not associated in a conceptual hierarchy like those discussed in Chapter 2. We can use a single verb to label events that are separated in time or space, as long as we understand the two events to be causally related. This is why we can label the events of Booth's fatal shooting of Lincoln on April 14th and Lincoln's death on April 15th with the single verb *kill*, as in (62), or the events of Josh flipping a wall switch and an overhead light being illuminated with the single verb *turn on*, as in (63).

(62) Booth killed Lincoln.

(63) Josh turned on the light.

Note that in addition to encoding a causal relationship between events in a single verb, as we do when we use the lexical causatives in (62) and (63), we have the option of describing causal chains using periphrastic causatives, as in (64) and (65), in which the relevant subparts of the causative event are encoded in two separate verbal units, one of which specifies the nature of the relationship between the event participants (i.e., that they are associated in a causal chain) and the other of which specifies the RESULT subevent of the causative.

(64) Booth made Lincoln die.

(65) Josh made the light come on.

Languages that have both lexical (or morphological) and periphrastic causatives (e.g., English, Japanese, Kannada, Korean) tend to split them so that the lexical causatives are more likely to be associated with events involving direct causation and periphrastic ones are more likely to be associated with events involving indirect causation (e.g., Lidz et al. 2003, Shibatani 1976, Wolff 2003). The conceptualization of an event as one involving direct causation has been variously attributed in the literature to event features including the intentionality of the event agent, the animacy of the event patient, physical contact between the event participants named in the event description, and the degree of closeness or continuity between events in the causal chain (McCawley 1976, Shibatani 1976, Talmy 1976, Wolff 2003).

Ideally, events of direct causation involve physical contact between a single intentional agent and a single inanimate patient: the less closely two events are related in a causal chain, the less likely speakers are to describe them with a lexical causative. So, for example, if Booth made Lincoln die not by shooting him, but by hypnotizing him and telling him to walk off a cliff into the Potomac River, it would be strange to describe this event with the lexical causative *kill*. Indeed, Wolff (2003) demonstrates that the use of lexical and periphrastic causatives by English speakers is correlated with the conceptualization of a given causal chain as consisting of one or two events. It should be noted, however, that at least in English, this particular pattern of linguistic realizations is merely a tendency on the part of speakers, and not a one that is entailed by the grammar, as made evident by the fact that it can be affected by our knowledge of the world. For example, because we know that we can't usually turn on light bulbs without the assistance of some mechanical apparatus like a lamp or a light switch, we can describe Josh's activity in (63) as *turning on* whether he flips a switch on a table lamp in his living room or presses a button on some console in another room that that controls all of the lights in his apartment.

We cannot, however, use a single verb to label an agent-driven activity and a change of state that are not causally related, even if the two events are identical to the means and result subevents of some other causative event. So, for example, if our baseball player swings a bat but doesn't hit anything, while at the same time a baseball flies across the field and over the outfield wall, we can't describe this set of events using the single verb *homer*, as in (66), because the two events are not causally related.

(66) # Maddux homered the ball.

Interestingly, furthermore, numerous investigations of causative verbs have pointed out that although causative verbs that encode a specific change of state but leave the causing event unspecified, like those in (52)–(56), are common, crosslinguistically there are no causative verbs that encode a specific activity without also specifying the result (e.g., Harley 1996, Rappaport Hovav & Levin 1998). In English, for example, we find many causative verbs that label a result as well as the existence of an unspecified causing activity. Like Maddux's movement of the ball in (32), the verbs *break*, *grow*, *split*, and *kill* in (67) all label a specific result (breaking, growing, splitting, dying) that is caused, in these cases, by an external agent without actually specifying what that agent did to achieve the result.

(67) a. Rory broke the lamp.

b. Jackson grew the squash.

c. Sookie split the bread.

d. Kirk killed the termites.

And again, as with the sentence in (32), we can rephrase the meanings of the sentences in (67) with the periphrastic causatives in (68), which separate the result and the notion of causation into two separate verbal units. (Here the optional "but I don't know how" clause highlights the unidentified status of the causing subevent.)

(68) a. Rory caused the lamp to break (but I don't know how she did it).

b. Jackson caused the squash to grow (but I don't know how he did it).

c. Sookie caused the bread to split (but I don't know how she did it).

d. Kirk caused the termites to die (but I don't know how he did it).

There are, however, no corresponding causative verbs in English that label some specific means that leads to an unspecified result. The meaning at issue here would be something like that expressed by the verbal units in (69), which combine a manner verb that labels an agent-driven activity (tapping, touching) with a verb that expresses only causation of an ambiguous nature (*alter*, *affect*):

(69) a. * Maddux tap-altered the ball (but I don’t know what he caused to happen).

b. * Rory touch-affected the lamp (but I don’t know what she caused to happen).

Likewise, there is no alternation equivalent to the Causative/Inchoative Alternation in which the noncausative variant of some verb labels an agent-driven activity when used in an unergative frame.

(70) a. Rory broke the lamp.

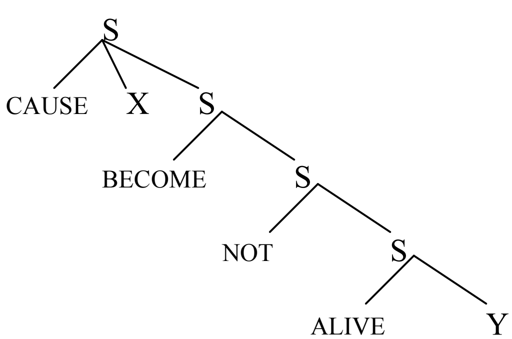
b. * Rory broke.

Crosslinguistically, then, adult speakers appear to exhibit a systematic gap in the way that they can attach labels to their conceptual representations of causative events. One crucial question that needs to be investigated is where this lexical gap comes from: i.e., whether this verb meaning is omitted from the world’s languages because of coincidences in the way that particular languages tend to encode events (i.e., we don't learn verbs like this because English, Italian, Japanese, etc. don't happen to have them) or because of some inherent cognitive constraints on our use of the language facility in general (i.e., we don’t learn them because language can’t have them). One possible answer to this question comes from the ways in which our conceptual representations of causative events map onto our linguistic representations.

3.2 Linguistic Representation

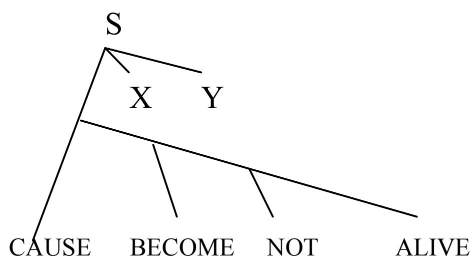
In consideration of the direct correspondences observed between linguistic descriptions and conceptual structure, current models of the organization of the mental information structure involved in language define event representations in terms of some kind of grammatical structure, detailed either in the syntax or the semantics (e.g., Chomsky 1995; Hale & Keyser 1993, 2002; Harley 1996; Jackendoff 1990; Kratzer 1996, 2000; Lidz 1998; Rappaport Hovav & Levin 1998). These theories have been informed significantly by early work in generative semantics, in which the representation of complex lexical items was accomplished through structural representations of decomposed semantic material that could be understood as individual lexical items through transformation operations just like those that operated on syntactic structures. For example, McCawley (1968, building on Gruber 1965) proposed that the verb *kill* can be decomposed into semantic components as “cause to become not alive.” Before the (optional) transformations that join these components, then, the meaning associated with the sentence “X killed Y” would be represented as in (71):

(71)



The structure in (72) is derived through successive application of a transformation that adjoins a lexical head (here, a predicate) to the next higher lexical head. (The trees in (71) and (72) are adapted from Figs. 3 and 6 in McCawley 1968: p. 73.)

(72)



McCawley's decomposition was accomplished at a pre-lexical level of semantic representation. After predicate-raising, then, the complex of semantic placeholders CAUSE BECOME NOT ALIVE could be replaced with the single lexical item *kill*. Later work on events has refined and elaborated these representations for different kinds of events and classes of verbs (e.g., Carter 1976, Dowty 1979, Jackendoff 1990, Levin & Rapoport 1988, Levin & Rappaport Hovav 1995, Parsons 1990, Pustejovsky 1991, Rappaport et al. 1993, Rappaport Hovav & Levin 1998) and has offered multiple different theories about their status in linguistic representations. Hale & Keyser (2002), for example, characterize these decomposed structures as lexical rather than semantic, arguing that the representations specify certain lexical properties in complex structures over which syntactic relations and principles are defined. In many current models of the organization of the mental information structure involved in language, the decomposition takes place in the syntax proper (e.g., Beck & Johnson 2004, Embick 2004, Harley 1996, Lidz 1998, Pylkkänen 2002, Tenny & Pustejovsky 2000, Travis 2000, von Stechow 1991); this is the analysis that will be assumed in this dissertation.[19]

In general, the decomposition of linguistic units into semantic primitives is motivated by the observation that certain "grammatical phenomena make reference to the internal structure of events" (Pustejovsky 1991: p. 73). Some of the grammatical phenomena that are commonly used as evidence for decomposition include selectional restrictions and aspectual features that carry over from the root forms of deverbal nouns (e.g., Levin & Rappaport Hovav 1995; Marantz 1984, 1997) and denominal verbs (e.g., Hale & Keyser 1999, Harley 1999) and ambiguities in the scope of certain sentential modifiers (e.g., Harley 1996, Pustejovsky 1991, Pylkkänen 2002, von Stechow 1991). An example of the latter sort of evidence is illustrated by the ambiguity of eventive verbs modified by the adverb *again*, as in (73).

(73) Jonathan started the car again.

a. Jonathan started the car, which he had done before.
b. Jonathan started the car, which had been on before.

The sentence in (73) has two readings, one, paraphrased in (73a), in which *again* modifies the causative event of *Jonathan's starting of the car* and another, paraphrased in (73b), in which

[19] Exactly where the structural complexity resides (i.e., in the lexicon or in the syntax) is a much debated issue that I will not be addressing in this dissertation (see Williams 2005 for an introduction). The data presented here are also consistent with models of the grammar that include some form of syntactic decomposition of event structure but that do not necessarily represent that decomposition in the syntax. For the purposes of this research program, it will be enough to assume that adult speakers of a language access meaning by matching lexical items against some kind of hierarchically structured representation. Whether those representations consist of syntactic, semantic, or purely conceptual material is a matter for future research.

again modifies the car's change of state from off to on (the result of *starting*). In order to access both of these readings, it must be the case that at some level we represent the single verb *start* as decomposed into two events, an event of causation and a change of state.

Crosslinguistic research in distributed morphology strongly suggests, furthermore, that this decomposition into basic meaning units is represented in the syntax (e.g., Halle & Marantz 1993, Harley 1995, 1996; Lidz 1998; Marantz 1997; Pylkkänen 2002). Harley (1996) argues, for example, that event-related semantic primitives like CAUSE and BECOME are overtly realized in the morphology of Japanese lexical causatives and their noncausative unaccusative intransitive complements, like the pair in (74) (sentences adapted from Harada 1999 and Okamoto in press):

(74) a. John-ga kabin-o kowa-si-ta.
John-NOM vase-ACC break-CAUSE-PAST
'John broke the vase.'

b. Kabin-ga kowa-re-ta.
vase-NOM break-BECOME-PAST
'The vase broke.'

Harley takes the presence of these overt morphological elements as evidence in support of an elaborated verbal structure that includes, at least, some head that specifies certain kinds of event type.

There is evidence, furthermore, that the syntactic decomposition of event-related semantic primitives has implications for language acquisition. Viau (2006) reports on the basis of a corpus study of the spontaneous speech of children learning English that children begin to use prepositional datives later than double-object datives. Examples of the two kinds of constructions are given in (75): note that both sentences describe the transfer of possession of the pie from Mike to Werner, but in the double-object construction the Goal argument *Werner* is expressed as an argument of the verb *give* while in the prepositional dative construction it is expressed as the object of the preposition *to*.

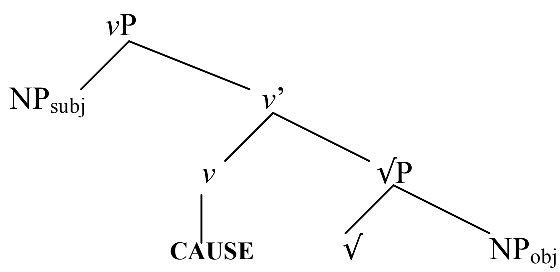
(75)	a. Mike gave a pie to Werner.	prepositional dative
	b. Mike gave Werner a pie.	double-object dative

Despite their similarities in meaning, Viau argues that semantic restrictions on the use of these two constructions reveal that they represent different syntactic decompositions, with the prepositional dative composed of the semantic primitives CAUSE and locative GO and the double-object dative composed of the primitives CAUSE and HAVE (Harley 1996, Oehrle 1976). He attributes the delay in the use of prepositional datives to late acquisition of the primitive locative GO, the acquisition of which he demonstrates to be statistically correlated with that of the prepositional dative.

The primary assumption underlying the syntactic decomposition of linguistic elements is that there is only one generative component in the grammar—the syntax. Semantic decomposition of linguistic elements is represented in the phrase structure, and the semantic relations between these elements are derived from their structural relations to each other (Hale & Keyser 1993, Marantz 1997). Under this analysis, then, distinct differences in meaning between various classes of verbs, including those differences between the eventive verbs in examples (37)–(41) above, arise because those classes of verbs are found in distinct syntactic structures.

As discussed in Chapter 2, evidence from a range of research areas within the cognitive sciences suggests that causatives are represented conceptually and linguistically as complex structures. On an account in which decomposition is represented in the grammar, the clausal architecture of a causative verb could be represented with something like the phrase-structure tree in (76).

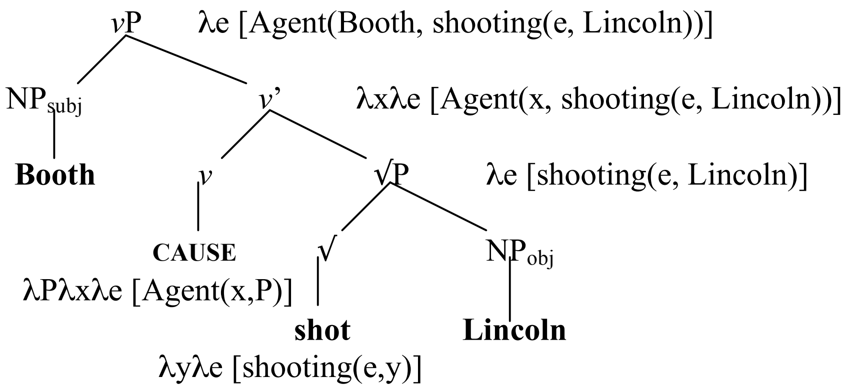
(76)



Here, the causative construction is a complex structure made up of two separate semantically contentful phrasal projections that represent the relationship between two events. The event denoted by the lower projection (√P) is a proper subpart of the event denoted by the upper one (*v*P). Causativity is syntactically represented as a light verb (CAUSE) in the event head *v* (Chomsky 1995, Hale & Keyser 2003, Kratzer 1996, etc.), and the external argument licensed by this light verb (realized as the specifier of *v*P) is understood to be the agent or causer of the event. The lower phrasal projection (√P) specifies the resulting change of state caused in some patient. Meaning is built up through a process of Functional Application. An example (adapted from Lidz & Williams 2002, Pylkkänen 2002) is given in (77).

(77) a. Booth shot Lincoln.

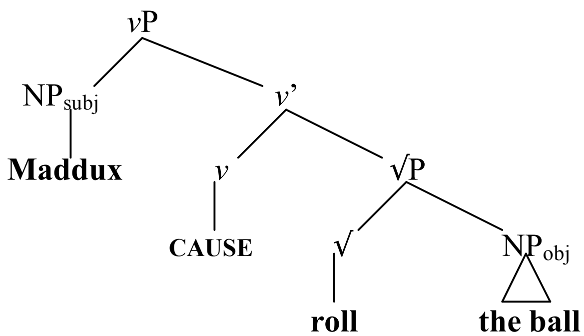
b.



In this system, the interpretation of an event as causative or noncausative is determined by which verbal category feature heads *v*P: i.e., *v*P is present for both causative and noncausative linguistic descriptions, but in the case of the latter, the event head *v* is realized as a noncausative light verb, e.g., BECOME (Harley 1996).

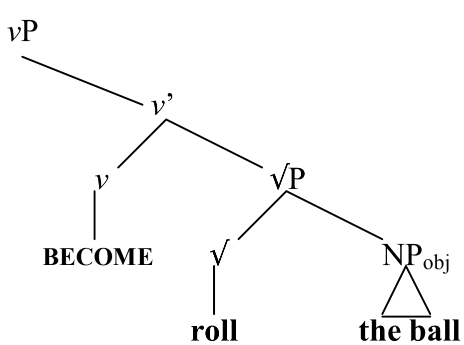
The trees that follow illustrate the application of this apparatus to the various descriptions of our *bunting* event. To begin, a causative verb like *roll* in the transitive frame (78a) would be represented as in (78b). Here, the event head *v* is realized as the unpronounced element CAUSE, and the causer of the event, *Maddux*, as its specifier. The √P specifies the result or end state of the event being described. So, here, Maddux is the causer of an event of ball rolling.

(78) a. Maddux rolled the ball.

b. 

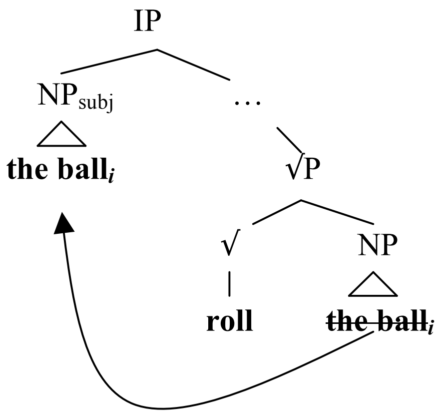
The unaccusative variant of a verb like *roll* (79a), on the other hand, labels a manner of motion without entailing that that motion has been caused by some external agent. Because there is no specified causer in the described event, CAUSE in the *v*P is replaced with the light verb BECOME in the structure (79b); as in (77b), the √P specifies the result or end state of the event—the rolling of the ball.

(79) a. The ball rolled.

b. 

Unlike CAUSE, BECOME does not introduce an external argument, and the surface syntax in (79a) arises as a result of movement of the NP “the ball” to the specifier of IP (80), driven both by the NP’s need for case-marking (which, in this case, it can receive only in subject position) and the Extended Projection Principle (which requires that every sentence have a subject).

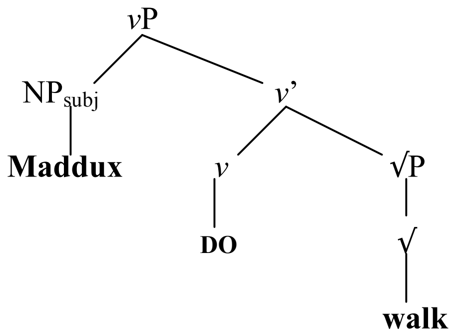
(80)



An unergative verb like *walk* in (81a), which labels the manner of an event without entailing any sort of causation, would be represented as in (81b). Again, the head of √P specifies a result or end state: this is an event of walking. Because the event described is not a causative one, causative *v*P is not projected. Instead, the event head *v* is realized as the light verb DO, which licenses the external argument *Maddux*, an event participant required by the meaning of *walk*.

(81) a. Maddux walked.

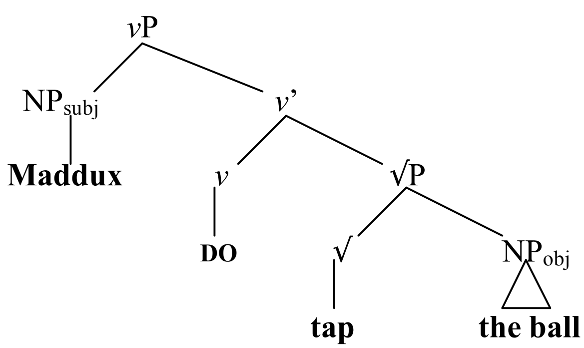
b.



The noncausative transitive verb *tap* (82a) is represented in a similar structure (82b):

(82) a. Maddux tapped the ball.

b.

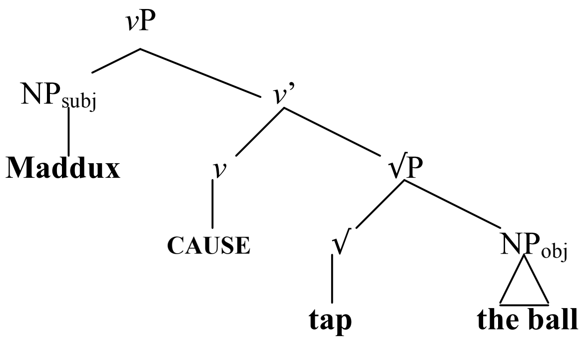


Here, the VP specifies both an activity and an affected object. Because the labeled activity does not entail that its object undergoes a change of state, no causative *v*P is projected. The subject of *tap*, like that of *walk*, is licensed by the light verb DO. The verb *cause* in (83) would also be represented as in (82b), with "cause" replacing "tap" as the activity specified in √P and "a change" replacing "the ball" as the patient.

(83) Maddux caused a change.

Assuming this kind of decompositional analysis, the lexical gap observed in (69) can be easily accounted for. Note first that there can be no verbs that encode causation by some specific means without also specifying a result because it is a property of the causative light verb that it takes a specified result as its internal argument. This grammatical prerequisite has the consequence that anytime a verb encodes causation, it must also encode result: because CAUSE by its very nature expresses the relationship between a specified agent and a specified end state, it is impossible to build a verb with CAUSE if the result is unspecified. A structure like (84), then, could only represent the linguistic description of an event in which Maddux caused the ball to tap (e.g., against something else), and not one in which Maddux's own tapping of the ball (e.g., with his hand) caused something else to happen.

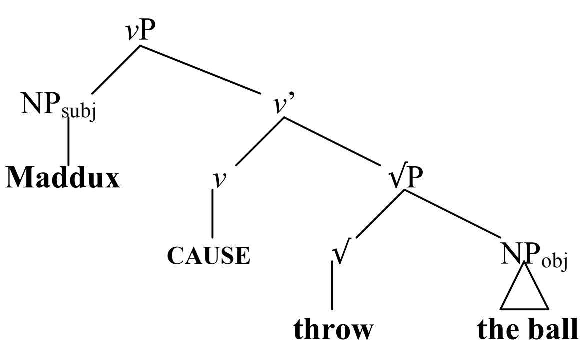
(84)



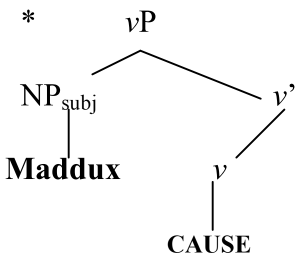
Adding a specified means to a causative structure can be accomplished by realizing the head √ as a lexical item that encodes a specific means, like *bunt* or *throw* (85), but never a verb like **tap-cause* in which there is no specified result (86).

(85) a. Maddux threw the ball.

b.



(86) *



Given our assumption that syntactic representations are tantamount to conceptual representations, we can articulate the explanation for this lexical gap in terms of facts about grammatical constituency as in (87) (see also McCawley 1968, Rappaport Hovav & Levin 1998):

(87) Constituency Constraint

Verbs cannot lexicalize pieces of structure that are not constituents in the lexical-semantic representation.

Given this constraint, causative verbs that specify a means but not a result are excluded because the light verb CAUSE <u>never</u> forms a constituent to the exclusion of a specified change of state in some patient, and lexicalizations can only be formed from grammatical constituents.

3.3 Discussion

The experimental studies summarized in Chapter 2 demonstrate that from infancy, we represent causal events as having internal structure. In Chapter 3, I have described evidence that our linguistic representations reflect this internal structure, with different kinds of event construals mapping onto different kinds of linguistic representations. We have seen, though, that it is not the case that every combination of conceptual primitives may be encoded in a single verb, because of constraints both on the way that events may be related in hierarchical structures and on the way that those event structures may be mapped onto language. Indeed, we have evidence that there exist lexical gaps in the minds of adult speakers that correspond directly with constraints on possible syntactic structures: i.e., events that do not form proper subsets at a given level of event representation cannot be encoded in a single verb. It appears, then, that both linguistic and conceptual representations of events impose constraints on verb meaning. The question remains, however, whether children and adults are subject to the same sets of constraints. We could ask, for example, whether this lexical gap arises independently in each speaker and/or language as the result of some lexicalization bias that is learned on the basis of language-specific distributional information[20], or whether it is due to inherent structural constraints on lexicalized meaning. In other words, do we have to learn not to postulate a noncausative verb that encodes [MEANS + RESULT] or a causative verb that encodes [MEANS + CAUSE] to the exclusion of a specified result as possible meanings for new verbs, or do these constraints come for free as part of the architecture of Universal Grammar? In the next chapter, I provide a summary of the literature on verb learning in children and outline a new set of studies that brings together insights gained from work examining the conceptual representation of event structure and work examining the syntactic expression of event structure to investigate the role that cognitive tools and constraints play in language acquisition.

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[20] Like the crosslinguistic biases observed in the lexicalization of path and manner (e.g., Havasi & Malik 2004, Havasi & Snedeker 2004, Naigles & Terrazas 1998).

Chapter 4

Verb Learning

Traditionally, it was assumed that children learned what the words of their language meant by pairing single word units that they had managed to pull out of the speech (or gesture) stream with discrete objects and events that they observed in their extralinguistic environment: i.e., by mapping words onto things in the world. It is possible that at least a few early words are learned on the basis of this kind of direct mapping. Indeed, it is well known that children's early vocabularies tend to include more nouns that label concrete observable objects than nouns labeling abstract concepts or verbs, which label relations between objects rather than objects themselves (e.g., Gentner 1981, 1982). This hypothesis is severely limited in its explanatory power, however, by the fact that the extralinguistic context rarely provides sufficient information for word learning: i.e., there is rarely a clear one-to-one mapping between the linguistic signal and the extralinguistic context.

Imagine, for example, that a caregiver and a young child are walking down the street and pass a group of children playing on a playground. The children are running and sliding and swinging and shouting and breathing and wearing jeans and hanging from the monkey bars and playing kickball, etc., and the caregiver points at them and describes their activities using a word that the child doesn't know: "Look! They're <u>blicking</u>." Assuming that the child is actually paying attention to the same scene that the caregiver is, and not, say, to a squirrel running in the other direction,[21] and that the child can identify the new word as a verb, there still are a lot of highly salient interpretations for this unfamiliar word: it could refer to any of the multiple observable events going on (e.g., running, sliding), or to some unobservable event (e.g., breathing, thinking), or to a combination of related events (e.g., playing kickball), or to some subpart of a single complex event (e.g., kicking), or to some subordinate (e.g., sprinting or panting) or superordinate (e.g., playing) level of taxonomic specificity. If word learning simply involves a mapping between single words and discrete objects and events in the world, it is unclear in this situation how the child would decide which of the multiple events going on in the playground scene is the one being encoded by the verb “blick.”

To compound this problem, observation of word-to-world mappings does not provide learners with a reliable source of information about word meanings. Caregivers rarely provide a consistent pairing of words and referents for children: they don’t, for example, point at every dog that they pass and say “Dog!” and they often use words that don’t correspond at all to what is happening in the world, as in the case of positive imperatives (e.g., "Eat your peas."), which are usually only uttered when the event referred to is <u>not</u> happening. In addition, there are many relational words (e.g., verbs, prepositions) that rely on knowledge of the speaker's perspective for full interpretation (compare *John gives the hat to Mary* with *Mary gets the hat from John*), and it is not clear how the child could learn which of these words refers to which perspective on the basis of nothing more than cross-situational observation, since whenever one of the relevant events is happening the other is as well. Even if the learner can figure out what entity or event

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[21] Harris et al. (1983) demonstrate that during parent-child play interactions in a laboratory setting, children aren’t attending to the intended referent of caregiver speech as much as 30–50% of the time.

some new word is referring to, say to a dog, they don’t know whether the word labels the whole animal or just a part of it, like a paw, or some attribute, like furriness. And even if they have some idea of which event or property is being referred to by a given word, they don't have any straightforward way of pinpointing the specificity of that description: e.g., does the word “dog” refer to a specific dog, to all members of the category of dogs, to all four-legged mammals, or to all animals?

As Gleitman (1990) put it, “the trouble is that an observer who notices *everything* can learn *nothing*, for there is no end of categories known and constructible to describe a situation” (p. 181). The problem is that if children have to rely primarily on observation of the world—the extralinguistic context—to figure out what words mean, then they’re either not getting enough information about what a word might mean (either because they’re not paying attention to the right thing, or because the word doesn’t describe something that is observable), or they’re getting too much information. To compound this challenge, there are things going on in the world that cannot be encoded with single verbs even though they occupy the same time and space, i.e., unrelated groups of events like the fan’s beer run and the batter’s pop fly described in our baseball game Chapter 2.

In the face of these obstacles, word learning seems like it should be a difficult task, yet children do it with apparent ease. By the time she is 18 months old, the average word learner is producing around 50 words; when she is 2 years old, she is acquiring up to 10 new words a day; and by the time she is 6 years old, she knows 10,000 words (the vocabulary of the average college student has been estimated at 150,000 words) (Hoff 2001). In order for them to learn words as quickly as they do, children can't be considering all of the infinite number of possible meanings for every new word that they encounter. Instead, it must be the case that they have some other kinds of tools at their disposal to help constrain their hypotheses about what words can mean—to give them some clue about what it is that they're supposed to be attending to in the world to link up to the sentences that they're hearing used to describe that world.

Given that there exist the kind of reliable mappings between verb meaning and verb syntax described in Chapter 3, it seems logical to postulate that a language learner would be able to use these kinds of regularities to break into the linguistic system. In theory, the facilitation provided by this kind of mapping could work in both directions: if a language learner knows the meaning of a verb, she should be able to use that information to figure out something about the syntax of constructions in which it may occur, and on the flip side, if she knows something about the syntactic frame in which a novel verb occurs, she should be able to use that information to figure out something about the verb's meaning. And in fact, there exists an ever-growing body of experimental literature demonstrating that both adults and children make use of just this kind of mapping as a tool to aid verb learning. Experimental studies carried out by proponents of the so-called Semantic Bootstrapping Hypothesis (Pinker 1984, 1989) have demonstrated that knowledge of a verb’s meaning (i.e., of the conceptual primitives encoded by a given verb that are relevant to linguistic machinery) informs hypotheses about how that verb may be extended to new syntactic frames (e.g., Brandone et al. 2006, Gropen et al. 1991; cf. Snedeker 2000). And there is complementary evidence from the literature on the so-called Syntactic Bootstrapping Hypothesis (Landau & Gleitman 1985) that language learners can use cues from the syntactic structures in which they encounter novel verbs to constrain their hypotheses about what those verbs mean (Bunger & Lidz 2004, 2006; Fisher et al. 1994; Gillette et al. 1999; Gleitman 1990;

Lidz 2006; Lidz et al. 2003; Naigles 1990, inter alia). In this chapter, I will summarize the results of several studies that demonstrate the utility of syntactic cues in verb learning, and I will describe a new set of studies that draw on this body of research to investigate the conceptual and linguistic constraints at play in the acquisition of novel causative verbs.

4.1 Syntactic Bootstrapping

Gleitman and colleagues have recently investigated the value of a range of information sources for word learning using what they call the Human Simulations Paradigm (e.g., Gillette et al. 1999, Snedeker 2000, Snedeker & Gleitman 2004, Snedeker et al. 1999). In this paradigm, adult learners are used to simulate the situation of children learning words, on the assumption that the two groups bring equivalent cognitive tools to the task of mapping single words onto conceptual representations. The participants in these studies are presented with silent videos of mothers interacting with their young children, and their task is to identify some target word used by the mother during the course of the interaction. This silent condition simulates the experience of a child who has only the extralinguistic context to inform word learning; in other conditions, information about the semantic and syntactic context of the target word are given independently, with the goal of quantifying the value of each of these sources of information.

To create the stimuli, Gillette et al. (1999) videotaped interactions between mothers and their 18–24 month-old children who were asked to "play naturally." From transcriptions of the taped sessions, they identified the 24 nouns and 24 verbs used most frequently by the mothers. These comprised the set of target words to be identified by the adult participants; all were extremely frequent both in adult-to-adult and in adult-to-child speech. For each target word, the experimenters then selected six short video clips in which the word was being used. These video sequences were presented to participants without sound, but with a “beep” inserted at the point in each clip at which the target word was uttered. Participants were asked to identify the word that corresponded to each beep. What the experimenters found was that concrete nouns were relatively easy for the adults to identify solely on the basis of this kind of extralinguistic observation—i.e., adults were relatively accurate at identifying words like “plane” or “ball” just by watching these silent videos—but that verbs (e.g., “hammer,” “pop,” “stand”) and more abstract nouns (e.g., “thing”) were very difficult for them to identify (44.9% of noun targets were identified correctly, but only 15.3% of verb targets, with successful identification of a word significantly correlated with its imageability).

Next, the experimenters presented participants with a range of additional information about the linguistic context in which each of the target verbs had been uttered. As a control, one group of participants was shown the same silent video clips described above and asked again to identify the target word being uttered at each beep. A second group of participants was asked to identify target verbs solely on the basis of an alphabetical list of the nouns that co-occurred with that verb in the caregiver utterances: e.g., for the target verb “call,” they received lists of nouns like “gramma, you” or “I, Markie.” A third group was shown both these lists of nouns and the sequences of silent videos that provided extralinguistic context for each word. A fourth group of participants was provided with the syntactic frame in which the target verb had been uttered with all of the content words (nouns and verbs) replaced with nonsense words: e.g., for “call,” they received lists of sentences like “Why don’t ver TARGET telfa?” or “Mek gonna TARGET litch.” A fifth group was provided with the full sentence context of the target verb—both the content words and the syntactic frame in which they had been uttered: e.g., "Why don't you TARGET gramma?" or "I'm gonna TARGET Markie." A sixth group was provided with all three sources of information: the full sentences and the video clips providing extralinguistic context.

The percent of target verbs correctly identified in each experimental condition is given in Table 4.1. What Gillette et al. (1999) found was that the more linguistic information that they provided their word learners with, the more accurate they were at identifying the target verbs. So although participants were quite bad at identifying verbs with just the silent videos as input, when they received additional information about the sentence in which the verb had been uttered—either semantic information or syntactic information or both—their identification of the target verbs was much more accurate. Even relatively unimageable verbs like "want" and "think" were identified 100% of the time in the Full Information condition. What Gleitman and her colleagues conclude from these experiments is that for adult learners, verb identification requires access to the linguistic context in which the verb is uttered as well as observation of the extralinguistic context.

Table 4.1

Percent of Target Verbs Correctly Identified in Each Condition Tested in the Human Simulations Paradigm (Gillette et al. 1999)

Condition	**Source of information**	**Percent of words identified**
Cross-situational Observation	Silent video clips	7.7%
Co-occurring Nouns	Alphabetical list of nouns	16.5%
Observation + Nouns	Video + list of nouns	29.0%
Syntactic Frame	Sentence with nonsense nouns and verbs	51.7%
Nouns + Frame	Sentence with only the verb unidentified	75.4%
Full Information	Video + sentence with only the verb unidentified	90.4%

There is clear evidence, moreover, that children also use this kind of linguistic information to learn verb meanings. As mentioned above, it is well established that one of the tools that children have at their disposal to apply to the task of verb learning is a learning heuristic commonly known as Syntactic Bootstrapping, the label given to the observation that children can use cues from syntax to constrain their hypotheses about the meanings of novel verbs that they encounter. The Syntactic Bootstrapping Hypothesis depends crucially on children's recognition of the regular mappings between verb meaning and verb syntax. The central claim of this theory is that children can observe the syntactic structures in which a novel verb occurs and then use that distributional information and the mapping rules (coupled with observation of the real-world context of use) to infer important information about the meaning of the verb: if a verb is used in X way, then it must be describing Y event or Y perspective on some event.

Studies (cited in Gleitman 1990 and Hirsh-Pasek & Golinkoff 1996) have shown that even children in the one-word stage of language production possess knowledge of the ways in which entities in a sentence map onto semantic arguments. Hirsh-Pasek et al. (1985) argue, for example, that the fact that children can distinguish between the event descriptions “Big Bird is tickling Cookie Monster” and “Cookie Monster is tickling Big Bird” provides evidence that children recognize not only the order of phrases or entities in a given sentence, but also the semantic significance of this ordering. Studies carried out by Naigles and associates on the acquisition of verbs denoting contact and/or causation (Naigles 1990, Naigles & Kako 1993, Naigles 1996) have demonstrated, moreover, that the use of syntax in verb learning begins very early: by the age of 24 months at least, children use information from the syntactic frame in which a novel verb is presented to determine the meaning of that verb.

Naigles (1990) tested the advantage provided to 2-year-old verb learners by syntactic cues using the Preferential Looking Paradigm developed by Spelke (1979) and Golinkoff et al. (1987) to study intermodal perception in infants. Her experiment consisted of two phases, a familiarization phase and a test phase. During familiarization, participants were presented with a video in which two actors—a duck and a bunny—were involved in two distinct but simultaneous activities, one in which one actor caused some change in the other, and one in which both actors engaged in the same noncausative activity. In one video, for example, the duck forces the bunny into an odd bending position, while at the same time the duck and the bunny have their arms extended and are spinning them in wide circles. Accompanying these videos, participants heard a novel verb, e.g., *gorp*, presented either in a transitive frame like "The duck is gorping the bunny" or in an intransitive frame like "The duck and the bunny are gorping."

After the children had been familiarized to the two-event video, they were presented simultaneously with separate videos of the two single events that comprised the multiple event scene shown during training, one on each of two video monitors placed side-by-side. For this trial, then, participants would see the forced bending event on one monitor and the arm-spinning event on the other. They were then asked to "Find gorping!"—i.e., to choose the single event that matched their interpretation of the novel verb presented during training. Naigles used a camera situated between the two video monitors to record where the child was looking, and based her analysis on the assumption that children would look at the event that matched the meaning of the novel verb.

What Naigles found was that 2-year-olds who heard the novel verb presented in a transitive frame interpreted it as a label for the causative event and those who heard the novel verb presented in an intransitive frame interpreted it as a label for the noncausative continuous activity. This study demonstrates, then, that the number of event participants mentioned in an input sentence can focus a language learner's attention on a specific aspect of a given scene and, crucially, that 2–year-old children can use this kind of syntactic cue to figure out which of two simultaneous events is being labeled by a novel verb. In a series of follow-up experiments, Naigles (1996) demonstrates that children can use information about the use of a novel verb use abstracted from across a range of syntactic frames to help determine its meaning, and Naigles & Bavin (2001) provide evidence, moreover, that 2–year-old children can generalize a novel verb from the frame in which it was taught to other syntactically appropriate frames. That is, if children are introduced to a novel verb in one frame (e.g., "She's lorping the ball"), they can pick out the referent of the novel verb even when the verb is presented in another frame (e.g., "The ball is lorping"). Fisher et al. (1994) demonstrate, moreover, that this influence of syntactic frames is not limited to comprehension: they report that when asked to describe a scene, the verbs that children provide are those that fit both the scene and the syntactic frame used to describe that scene.

Indeed, there is evidence that young children are "frame compliant" (Naigles et al. 1992, 1993), i.e., they tend to alter their interpretation of a verb to fit the syntactic environment in which it is presented. Several studies have shown that in act-out tasks in which 2– and 3–year-old children are presented with familiar verbs in a novel syntactic frame, they systematically alter the meaning of the verb to fit the frame, so that a transitive sentence like "The zebra falls the giraffe" is interpreted as a causative (i.e., "The zebra makes the giraffe fall"), whereas an intransitive sentence like "The zebra brings to the table" is interpreted as a non-causative (e.g., Lidz et al. 2003, 2004; Naigles et al. 1992, 1993).

Crosslinguistic data suggests, moreover, that the mapping between verb syntax and verb meaning imposes a constraint on acquisition that precedes learned responses to linguistic input. Lidz et al. 2003 demonstrate, for example, that 3–year-old children learning Kannada base their interpretations of novel verbs presented in an act-out task on the number of arguments they occur with in the input sentence, even when that interpretation violates information provided by a more reliable morphological cue to verb meaning. In their study, children acted out two-argument sentences as causative events and one-argument sentences as noncausative, independent of the presence or absence of a causative morpheme.

This automatic mapping between argument structure and verb meaning does not seem to rely on explicit information about the event participants linked to each semantic role expressed in a given sentence. Fisher (1996, 2002) demonstrates, for example, that even when event participants are identified with ambiguous pronouns (e.g., describing an event with the sentence "She's blicking her" when both participants are female), preschoolers can use the number of arguments in an input sentence to guide their interpretation of a novel verb.[22] And Yuan & Fisher (2006) show that 2-year-olds can use this information to make inferences about the meaning of novel verbs even when those verbs are introduced in the absence of any extralinguistic context. Fernandes et al. (in press) demonstrate, moreover, that 28–month-old children can abstract away from changes in event participants when learning novel verb labels for causative events, such

[22] Lidz et al. 2006 argue that too much information about known words in a sentence may actually impose a processing constraint on verb learning, despite the potential semantic contribution from lexical content.

that argument positions in an input sentence (subject, object) are mapped onto whichever event participants are fulfilling a given semantic role at a given time and not onto the event participants first associated with those semantic roles. In their study, subjects of intransitive sentences are mapped onto the undergoer of the causative event and subjects and objects of a transitive sentence are mapped onto the causer and undergoer of a causative event, respectively, even if the semantic roles of the two event participants are reversed (i.e., if the familiarized causer becomes the entity undergoing the change of state). Together, these studies suggest that children's early event representations are not tied irretrievably to the particular event that they first associated with a given word, but rather that they encode abstract mappings between argument positions and semantic roles (see also Waxman et al. 2006).

4.2 Learning Labels for Causative Events

There is compelling evidence, then, in support of Landau & Gleitman's (1985) proposal that children, like adults, are influenced by their knowledge of syntax when postulating interpretations for a novel verb. Very little work, however, has examined the precise nature of the meanings that children assign to verbs when they learn them in this way: i.e., how flexible they are in the linguistic representations they associate with novel verbs and how those linguistic representations map onto the relevant event representations. What I would like to demonstrate is that by understanding the kinds of meanings that children assign to novel verbs we can, in turn, learn something about the mechanisms and constraints that underlie the process of lexicalization. It is well established, for example, that children as young as 14 months of age can associate novel verbs with causative events (e.g., Behrend 1990; Casasola & Cohen 2000; Fisher 1996, 2002; Gentner 1978; Naigles 1990; Wolff 2003). What has yet to be satisfactorily determined, however, is exactly what children think these verbs mean, i.e., which (sub)parts of these complex events children encode in novel verbs. As discussed in Chapter 2, studies in event perception have revealed that both children and adults represent causative events as internally complex, composed of multiple hierarchically related subevents. And as discussed in Chapter 3, we know that adults have many options for encoding the subevents of a complex causative in a single verb, each of which corresponds to a distinct linguistic representation. Given this evidence that children can use cues from syntax to figure out the meanings of novel verbs, we might wonder whether they are limited to using this ability to distinguish between multiple distinct events in the world (e.g., Naigles 1990), or whether they can also use it to parse and label single events that are internally complex.

The few reported studies that have investigated the meanings that children assign to verbs labeling causative events (e.g., Behrend 1990, Gentner 1978) are limited in that they do not adequately acknowledge either the systematic mapping between conceptual and linguistic representations of events or the role that that mapping plays in informing verb acquisition. Behrend (1990), for example, familiarizes 3– and 5–year-old children to videos of instrument-mediated causative events paired with event descriptions that include a novel verb. At test, he shows a sequence of three new events, each of which differs from the training event in either the action of the causative agent, the instrument being used, or the resulting change of state, and asks his participants to decide whether each of the new events can be labeled with the same novel verb that was introduced as a label for the causative event. Behrend's reported results are intriguing: he finds that participants of both ages are least willing to accept changes to the result of the causative event, followed by changes to the action and the instrument, respectively. The validity of this finding is called into question, however, by fundamental flaws in the experimental design. First, Behrend presents all of his novel verbs in intransitive sentences in which the single argument is mapped to the event's agent, "Watch this person, she is ___," a syntactic frame that is not usually associated with causative events. Second, he doesn't carefully control the features of the causative familiarization events that are repeated in test events: e.g., several alterations of the familiarization events that are meant to change agent actions also result in changes to the result subevent and/or in events that are no longer causative. In fact, Behrend's finding that participants of both ages are less likely to accept changes to results than to agent actions collapses when he controls for independent rankings of the degree to which the various sets of test events differ from the familiarized causatives.[23]

Our goal, then, was to improve upon these studies by using children's sensitivity to the systematic relationships between argument structure and event representations to investigate the meanings that they assign to novel verbs associated with causative events (Bunger & Lidz 2004). In addition, we wanted to confirm the strength of syntactic bootstrapping as a learning mechanism by investigating its utility in helping children to identify and label the subparts of internally complex events.

[23] It is also important to point out that the instrument change test events, which involve change to an event participant, are not entirely parallel to the action and result change test events, which involve changes to entire subevents of the causative. This comparison between the relative importance to event representation of individual participants and the events that they undergo is an interesting one that has not, to my knowledge, been replicated, and Behrend's finding that changes to instruments are more acceptable than changes to either subevent holds up even after he controls for differences between familiarization and test events. If this finding is correct, it would provide more evidence in support of the argument that event representations encode abstract mappings between event participants and their roles rather than specific information about the identity of individual participants.

To investigate these questions, we presented 2–year-old children learning English with videos of complex causative events in a preferential looking task. During the familiarization phase of the experiment, children saw a causative event, like a girl dribbling a ball, that was labeled with a novel verb. Novel verbs were presented either in an unaccusative intransitive syntactic frame ("Look! The ball is pimming.") or in a transitive frame ("Look! The girl is pimming the ball."). At test, children were presented with two new events, simultaneously and on opposite sides of a large video monitor, that corresponded to the separate subevents depicting the means and the result of the complex causative presented during familiarization. In the case of the causative dribbling event, the means test event would depict the girl patting a ball that did not bounce, and the result test event would depict a ball bouncing while the girl stood idly by. Participants were then asked to decide which of these two test (sub)events could also be labeled by the novel verb.

Visual fixation data reveal that children who heard the novel verb in an unaccusative intransitive frame were more likely than participants who heard the verb in a transitive frame to interpret it as a label for the result subevent. This result is not surprising, given that in English, the unaccusative variant of a causative verb invariably labels the result subevent of a complex causative, as illustrated by *bounce* in (88), while the verb in a transitive frame may label either the result of a causative event (89a), the entire causative event (89b), or just a means activity (89c).

(88) The ball bounced. RESULT

(89) a. The girl bounced the ball. CAUSE + RESULT

b. The girl dribbled the ball. MEANS + CAUSE + RESULT

c. The girl patted the ball. MEANS

Note, furthermore, that if participants in this study were biased to interpret novel verbs in transitive frames as labels for causative events (as in, e.g., Lidz et al. 2003; see Slobin 1985 for a hypothesis about the conceptual biases that underlie this tendency), neither of the test events provided a suitable match for the verb because neither depicted a causative event.

This study provides further evidence that observation of the syntactic behavior of a novel verb provides information about the kind of event that the verb labels. Note that if the syntactic nature of the input did not influence the interpretations that children assigned to our novel verbs, then we would not see this difference in attention at test between the Unaccusative and Transitive conditions. Likewise, if these children weren't representing the causative events as having internal structure, the syntax would not have been able to guide them to these different interpretations: i.e., if their representations of these causative events did not include a result subpart, then even children who only heard the novel verb in the unaccusative intransitive frame wouldn't have been able to tease that subevent apart from the whole event. In general, then, it seems that we can use syntactic bootstrapping not only to tell us about the way that labels for events are acquired, but also to tell us something about how those events are represented by the learner.

The results of this study demonstrate that 2–year-old children do, in fact, represent complex causative events as having internal structure, and moreover, that they can use syntax to identify and label the subparts of these internally complex events. Here, when the linguistic input focused children's attention on the result of a given causative event, they interpreted a novel verb as describing that subevent.

Recall, however, that this is only one of the meaning options available to adults labeling causative events. We know that adult speakers can describe a complex causative event using a single verb that encodes any of the individual subparts of the causative (MEANS, CAUSE, RESULT) or various combinations of the subparts (CAUSE + RESULT, MEANS + CAUSE + RESULT). And we also know that there are limitations on the subparts that adults can encode as a single verb that correspond directly to constraints on conceptual and linguistic event representations. What we don’t know is how language learners figure out which of these meanings are possible and which are not possible in their language.

It is clear that the hypotheses that language learners postulate for new words are guided by multiple constraints, some arising from default assumptions about the mapping between linguistic and conceptual representations, and others drawn from observation of language-specific lexicalization patterns or experience with speakers and the world (see Woodward 2000 for a cogent summary of both categories of constraints). In light of the recent trend to use adults to model word learning in children (e.g., Gillette et al. 1999, Snedeker 2000, Snedeker & Gleitman 2004, Snedeker et al. 1999), we might wonder whether these two groups of word learners are guided by the same sets of constraints and whether they are accessing the same meanings.

We know that the mechanisms that guide word learning change over the course of development. For example, the default strategy of frame compliance (changing the meaning of a verb to fit the syntactic frame in which it is presented) observed in young word learners declines with age (e.g., Lidz et al. 2003; Naigles et al. 1992, 1993), shifting to a strategy of verb compliance (changing the syntactic frame in which a verb appears to fit its meaning) as learners pick up on more reliable syntactic and morphological cues in the input. In addition, adult language learners may employ word-learning strategies derived from lexicalization patterns in their own language, like language-specific probabilistic information about the meanings of known verbs, to guide their hypotheses about the meaning of novel verbs. Havasi & Malik (2004), for example, demonstrate that adults (and children older than 3.5 years) who were biased to lexicalize manner and motion in a single verb (excluding path) were more likely to extend a novel verb by manner, and vice versa. The influence of this kind of word learning strategy (not to mention countless others) creates a problem for the study of adult language learners because it becomes difficult to tease apart the effects of these learned strategies or biases from the ones that derive from the cognitive architecture. That is, if an adult learner can't be led to associate a novel verb with some particular meaning (e.g., means and causation to the exclusion of a specified result), we don't know whether that gap is the result of default constraints or learned biases.

These developmental studies show, on the other hand, that 2–year-old children have not yet had the opportunity to develop these kinds of learned language-specific biases, whether because of constraints imposed by cognitive development or due to a simple lack of exposure to the relevant lexicalizations. Investigating verb learning in young children, then, provides a powerful study of the mechanisms underlying verb acquisition. Within this population of language learners, while preferences for the meanings of novel verbs will certainly be driven by universal constraints on the structure of language, it is less likely that they will be biased by word-learning strategies derived from acquired knowledge about their target language or about the world.[24] Given this, it should be easier to guide children to interpret a verb as encoding a meaning that is uncommon or absent in some language than it would be to guide adults to the same interpretation, assuming that that meaning is possible to represent at all.

Another question that has not yet been adequately addressed in the experimental literature is what kind of flexibility young learners allow when encoding the meanings of novel verbs: i.e., whether their representations of novel verbs are tied to the individual events that they first associated with the verb or whether they, like adults, represent verb meanings as abstract relationships that hold between sets of event participants (e.g., Gallistel 2001, Kersten & Billman 1997). For adults, verb meanings are not generally tied to the linguistic or extralinguistic context in which they were first learned: because verbs are understood to label categories of events, and not specific events, adults can generalize them to new situations and new syntactic frames. We as adults understand, for example, that the verb "shoot" labels any event of shooting: not just Booth's shooting of Lincoln with a gun, but also the pirate Blackbeard's shooting of an enemy ship with his cannon or a 6th grader's shooting of a rubber band at his math teacher. We can even understand semantic extensions of this word that do not involve projectiles, for example, a photographer shooting a picture.

There is some debate, however, over whether children's earliest verb meanings are equally abstract (e.g., Lucariello & Rifkin 1986, Poulin-Dubois & Forbes 2006, Tomasello 2000). Tomasello's Island Hypothesis, for example, postulates that children start out with

[24] This is not to say that early lexicalization preferences are not driven by extralinguistic perceptual/conceptual preferences, e.g., a preference for results or end states over event beginnings (Lakusta & Landau 2005, Regier 1996, Wagner & Carey 2003, Woodward 1998, etc.). An explicit examination of those preferences is, however, beyond the scope of this work.

representations of individual verbs and gradually merge them to form more abstract categories (Tomasello 2000). He bases this theory largely on evidence from production studies that suggest that children are unwilling to extend novel verbs learned in a specific linguistic context to new syntactic frames. Poulin-Dubois & Forbes (2006) present complementary evidence from an experimental study of the changes that children will accept in the events associated with novel verbs that demonstrates that at 21 months of age, children use perceptual similarity between events rather than categorization on the basis of "unobvious commonalities" (p. 278) to extend word meanings. This finding suggests that young children's representations of verb meaning are highly context-specific, such that the events that they are willing to associate with a given verb must be maximally like the ones they first associate with the verb. On the contrary, however, experimental evidence demonstrating that children can use purely structural information from the syntactic frame (or frames) in which a novel verb is presented (e.g.,. Fisher 1996, 2002) or syntactic information highlighted by structural priming (Thothathiri & Snedeker 2006) to make predictions about verb meanings suggests that they are, indeed, tied to abstract information about event categories rather than to specific events.

The experiments described in Chapters 5, 6, and 7 have been designed to bridge the gaps between work examining the conceptual representation of event structure, work examining the syntactic expression of event structure, and work examining the role that cognitive tools and constraints play in language acquisition. Together, these three areas raise important questions about the effect of prelinguistic event representations on word learning, the complex mapping between the linguistic and conceptual representations of events, and the nature of the cognitive tools that drive our acquisition and use of language. Specifically, my goal is to investigate the range of meanings that children are willing to encode in single verbs associated with causative events and how those options are guided by constraints on conceptual and linguistic event representations. The first step in this investigation will be to determine which combinations of the subevents of a complex causative 2–year-old children are willing to label with a single verb. The second step will be to probe the degree of specificity these learners encode in verb representations, i.e., what kind of flexibility they will allow in the events associated with verbs labeling causative events. In order to tease apart the effects of inherent constraints on the mapping between linguistic and conceptual event representations and word learning strategies derived on the basis of experience with language and the world, I will compare the behavior of children to that of adults in verb-learning tasks to investigate how learners resolve conflicts between hypothesized verb meanings and new information from the extralinguistic context and how the strategies that learners use change as they gain more experience with the linguistic and extralinguistic input.

Chapter 5

Experimental Design

Cognizant of both conceptual and linguistic constraints on possible verb meanings, we designed a set of four closely integrated experiments to investigate how these constraints play out over the course of language development. Our goals were to determine how children are willing to map novel verbs onto causative events and how their interpretations change as they acquire more information about their language, i.e., to find out whether 2-year-olds and adults apply the same constraints to the encoding of novel verbs. In this chapter, I summarize the elements that are common to all four experiments: participant populations, stimulus materials, and basic procedural techniques. In the chapters that follow, I describe each individual experiment in more detail: Chapter 6 provides an account of two experiments designed to investigate which of the subevents of a complex causative language learners are willing to encode in a single verb, and Chapter 7, two experiments that investigate the changes that learners are willing to accept in causative events labeled with single verbs.

In the entire set of experiments, several features affecting the perceived cause and/or result of a controlled set of causative events were manipulated, along with the syntactic context in which a novel verb labeling the event was presented, with the idea that participant ability (or inability) to interpret the novel verb as a label for one or more subparts of the complex causative event would be informative about the inherent and learned biases that constrain the mapping of event representations to language.

5.1 Participants

Two populations of language learners were tested in these studies: children of approximately 2 years of age, who are just beginning to acquire verbs rapidly and efficiently, and normal adults, who have presumably already developed some effective strategies for verb learning. Comparisons of reactions to the stimuli across these different groups of participants were planned to investigate how lexicalization preferences change with development.

5.1.1 Children

Children of the appropriate age (22–26 months) were recruited from a large database of families who had previously expressed interest in participating in studies in early linguistic and conceptual development. Each child who participated received a small toy or book.

The final set of children available for analysis consisted of 113 participants (54 male and 59 female participants distributed evenly across experiments and conditions) ranging in age from 22;1 (months;days) to 26;1 (mean age 24;1). All were being raised in environments in which they received no more than 10% of their input in a language other than English. Their mean productive vocabulary (words that the child understands and uses) was 332 out of a possible 680 words, as measured by parental report using The MacArthur Communicative Development Inventory: Words and Sentences (Fenson et al. 1993). Parents were also asked to report whether they had heard their children say any of an additional set of words that labeled objects and actions that were presented in the stimulus videos but were not listed on the MacArthur inventory of vocabulary (a complete list of these words can be found in Appendix 1, Table A1): mean productive competence for these additional words was 3 out of a possible 11 words.

An additional 52 children were run in the study, but were excluded from analysis for at least one of the following reasons: age (including children born before a full term of gestation; *n* = 6), parent-reported speech or hearing problems (*n* = 1), language background (*n* = 2), unwillingness to complete the experiment (*n* = 2), inattention during the test phase for more than 30% on more than two trials (*n* = 10), interference from accompanying parent (*n* = 5), experimenter error/equipment malfunction (*n* = 9), or study design (*n* = 17).

5.1.2 Adults

Adult participants (*n* = 81, mean age 20 years) were undergraduates at Northwestern University and received credit in linguistics or psychology courses for participating. All adults included in the analysis were native monolingual speakers of English and had no self-reported history of relevant speech or hearing problems (*n* = 19 excluded for language background, *n* = 1 excluded for self-reported speech or hearing problems).

5.2 Stimulus Design

This experiment employs the preferential-looking paradigm developed by Spelke (1979) and Golinkoff et al. (1987) to study intermodal perception in infants, with modifications informed by studies on the acquisition of nouns and adjectives (Waxman & Booth 2001, Waxman & Klibanoff 2000). In a preferential-looking study, a child is presented with two scenes displayed simultaneously on opposite sides of the screen of a large video monitor accompanied by some speech stimulus. Previous work (e.g., Golinkoff et al. 1987) has shown that children tend to look longer at the scene that matches the speech stimulus.

5.2.1 Visual stimuli

Our version of this procedure consists of two phases: familiarization and test. The familiarization phase was identical in all four of the experiments. During this phase, a single causative event was presented on the projection screen in the presence of an auditory event description that, in the case of all but the No Word control condition, included a novel verb (e.g., “Do you see the girl pimming?). The causative events all involved human agents causing some observable, instrument-mediated change of state in an inanimate object, e.g., in one causative event a girl hits a ball repeatedly with a tennis racquet, causing it to bounce up and down (Figure 5.1). Our four familiarization events differed in how closely the causing activity and the change of state were associated: two of the events, including the one involving the girl and the ball, involved direct mechanical causation (*pimming* and *lorping*); and the other two involved causal chains that were more indirect (*greking* and *blicking*). In one of the more indirect events, a boy pumps a bicycle pump that is attached by a cord to a box holding a plastic garden flower: when he pumps, the flower spins (Figure 5.2). A complete list of the causative events used as familiarization stimuli is given in Table 5.1. During the familiarization phase, a given causative event was shown four times (6 s each presentation) and on both sides of the screen, first once on each of the left and right sides in sequence, and then twice on both sides simultaneously.

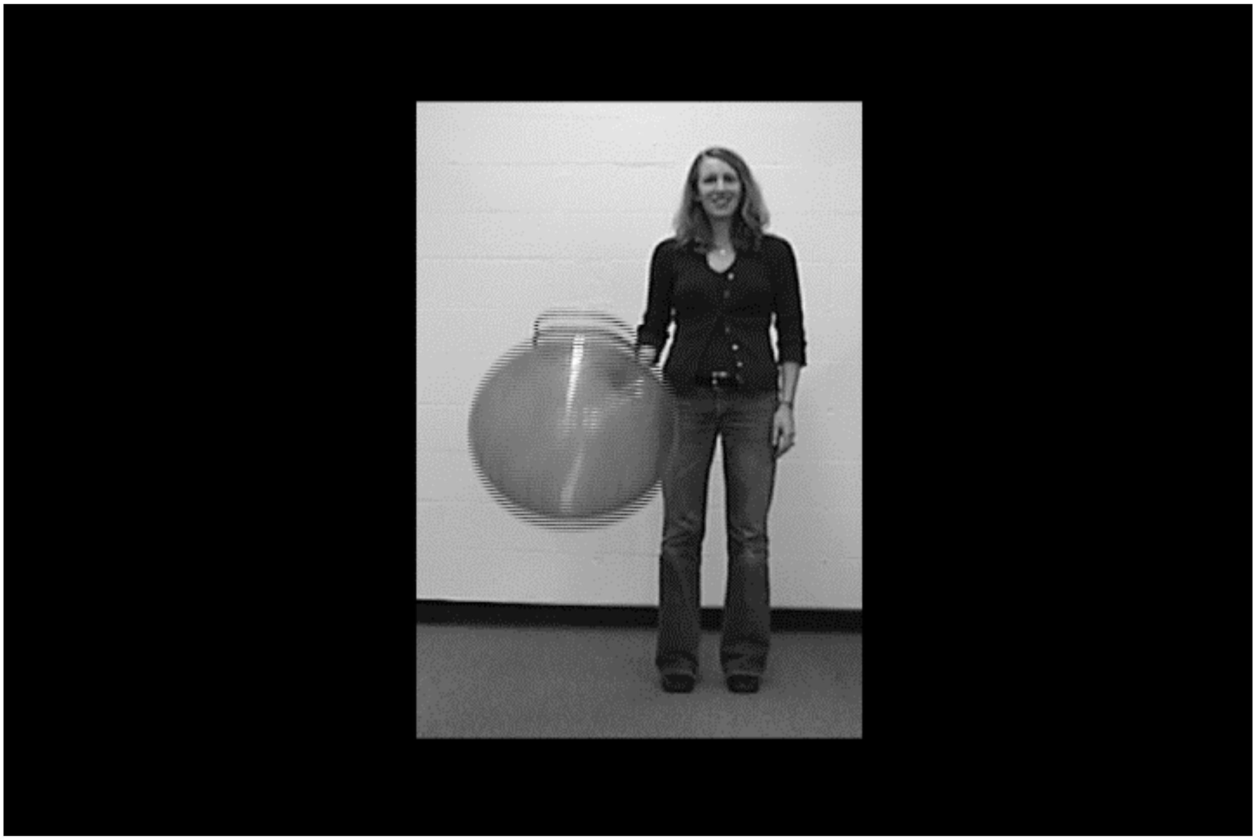

***Figure 5.1*. Still image from causative event in which a girl makes a ball bounce by hitting it with a tennis racquet (*pimming*).**

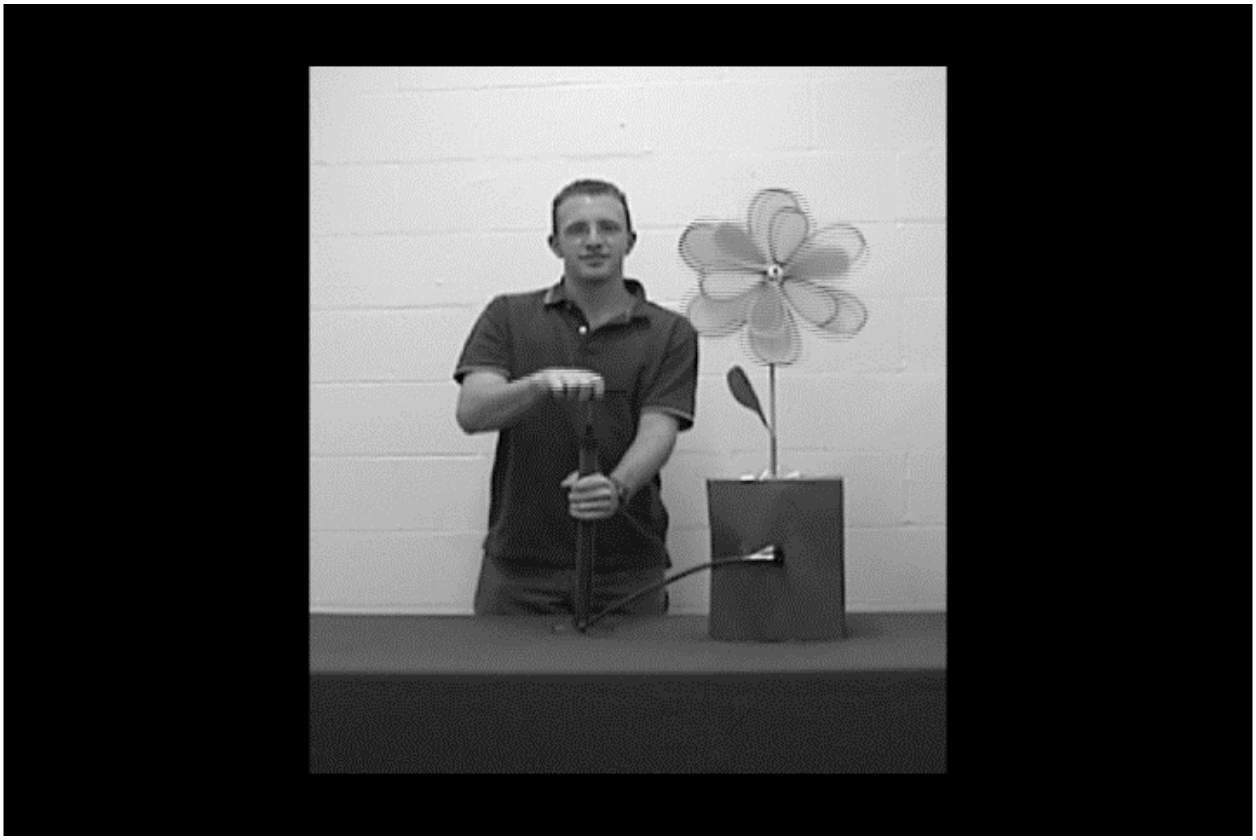

***Figure 5.2*. Still image from causative event in which a boy makes a flower spin by pumping a bicycle pump (*blicking*).**

Incorporating an experimental modification introduced in the literature on noun and adjective acquisition (e.g., Booth in press, Waxman & Booth 2001, Waxman & Klibanoff 2000, Waxman et al. 2006; summarized in Waxman 2004), during the familiarization phase, we presented participants with a noncausative contrast event involving the same person and objects involved in the causative familiarization events. Between the third and fourth presentations of our causative familiarization events, participants saw a 6 s contrast event in which the agent of the causative event was engaged in a different (noncausative) activity involving the inanimate object (Table 5.1). Accompanying this contrast event, they heard an event description that repeated the novel verb presented during familiarization, but that made it clear that the referent of that verb was not depicted (e.g., “Oh no! Now the girl is not pimming.”). Previous studies of verb learning have suggested that young children tend to include an event’s patient in the meaning of a novel verb labeling the action performed on it, such that they have trouble extending the novel verb to label the same action performed on a new object (e.g., Imai 2002; Imai et al. 2002, 2004, 2006). The goal of our contrast phase was, in part, to constrain the hypotheses postulated for our novel verbs by pointing out the event features that were not included in the meaning of the novel verb (viz., the entities involved in the event).

During the familiarization phase, each presentation of an event (causative or contrast) was accompanied by two mentions of the novel verb, for a total of 10 mentions.

Table 5.1

Familiarization and Contrast Events

Novel verb	**Causative event**	**Contrast event**
pim	girl hits ball with tennis racquet, ball bounces	girl swings ball back and forth
lorp	boy hits ring tower with stick, tower rocks back and forth	boy turns tower over and over
blick	boy pumps bike pump attached to garden flower, flower spins	boy waves flower back and forth
grek	girl turns crank attached to light, light bulb turns on	girl puts light on her head

During the test phase, participants were presented with two new events that represented either individual subevents (MEANS or RESULT) of the causative presented during familiarization (Experiments 1 and 2) or a causative variation of the familiarization event in which one of the subevents had been changed (Experiments 3 and 4). To increase the likelihood that our word learners associated novel verbs with actions rather than event participants, both test events involved the same event participants (agent, instrument, patient) presented during familiarization.[25] The two test events were shown simultaneously on opposite sides of the screen, and the auditory stimulus directed participants to find the action represented by the novel verb introduced during familiarization. The four experiments varied systematically in the ways in which test events differed from the familiarized causative. More detailed information about the test events for each experiment is given in Chapters 6 and 7. Each pair of 6 s test events was presented twice, separated by 0.5 s of black screen, resulting in a 12 s test phase.

Participant attention was centered before each trial by the presentation of a 5 s (re)centering stimulus (a picture of a baby accompanied by a giggle), and the side of the projection screen on which the causative event was first presented during familiarization was counterbalanced, as was the location (right vs. left side) of the new events shown during the test phase. A more detailed schematic of a representative trial can be found in Appendix 1, Table A2.

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[25] Imai (2002) points out that "children can generalize verbs based on the identity of the action better when the object is similar to the original exemplar" (Slide 47).

5.2.2 Auditory stimuli

Experimental conditions differed between participants and were distinguished by the kind of auditory input participants received during familiarization. Examples of the input sentences presented during familiarization and test in each condition are given in Table 5.2. Participants in Unaccusative conditions heard an event description that included a novel verb presented in an unaccusative intransitive sentence; participants in Unergative conditions heard a novel verb presented in an unergative intransitive sentence; and participants in Transitive conditions heard a novel verb presented in a transitive sentence. This particular set of syntactic frames was chosen as input sentences for novel verb conditions because of the robust cues that they provide about the meaning of the verbs they contain. It is well known that verbs in an unaccusative intransitive frame invariably label the result of a causative event (90a), while verbs in an unergative intransitive frame label some activity that an agent is engaged in (90b). There is evidence, moreover that despite the ambiguity of the transitive frame, children of this age interpret verbs in transitive sentences (90c) as labels for causative events (e.g., Lidz et al. 2003).

(90) a. The ball is bouncing.

b. The boy is pumping.

c. The girl is dribbling the ball.

It was not the case that each novel verb in each syntactic frame corresponded to an existing English word, but all corresponded to possible linguistic representations when used to label the causative familiarization events.

Table 5.2

Experimental Conditions

Syntactic frame	Familiarization input	Test question
Unaccusative verb	"Look! The ball is pimming. Do you see the ball pimming?"	“Do you see pimming? Where’s pimming now?”
Unergative verb	"Look! The girl is pimming. Do you see the girl pimming?"	“Do you see pimming? Where’s pimming now?”
Transitive verb	"Look! The girl is pimming the ball. Do you see the girl pimming the ball?"	“Do you see pimming? Where’s pimming now?”
No Word	"Hey—look at that! Do you see what’s happening?"	“What do you see? What’s happening now?”

Participants in No Word control conditions were presented with event descriptions that did not include a novel verb, but instead invited them to attend generally to the familiarization and test events. The goal of this condition was to establish baseline preferences dictated by extralinguistic perceptual or conceptual biases for each pair of test events in the absence of a novel verb label.

5.3 Materials

Participants were presented with synchronized video and auditory stimuli that had been digitized to a single source to ensure consistent presentation of stimuli across participants and experimenters.

Videos consisted of events involving live actors and familiar real-world objects that depicted either isolated causative events, subparts of those events, or variations on them. Events were recorded using a Sony Digital8 Handycam in the same bare environment and against a neutral background. Raw video recordings were edited into stimulus videos using Apple's Final Cut Pro 4 software. Videos were recorded and presented in color.

Auditory stimuli consisted of recordings of a single talker producing sentences from a script using child-directed speech intonation. The talker was encouraged to produce the sentences as though talking to an actual child rather than reading from the script. Recordings were made in a sound-attenuated booth and were live-monitored for gross misarticulation, hesitation, and inconsistency of speaking rate. Scripts were recorded at a 16-kHz sampling rate, converted to a binary format, and then edited by hand into sentence-sized files by removing the silent portions before and after each target utterance using version 4.0 of the Praat software

(Boersma & Weenink 2005). Some files were manipulated for length (while preserving pitch) using Praat's PSOLA function. After extraction, sound files were added to the audio tracks of the Final Cut videos in synchronization with the video output.

Synchronized audio and video tracks for completed stimuli were exported to digital 8mm tapes and presented to participants at a speed of 30 frames/s.

5.4 Apparatus

5.4.1 Children

Children were tested in a 10 by 13 ft room. The room was quiet and dimly lit by a shaded 60W lamp situated approximately 4 ft to the left of and behind the child. Stimuli were presented to participants using a projection system consisting of a ceiling-mounted InFocus projector, a 4.5 by 4.5 ft white projection screen situated approximately 6 ft from the participants, and two Altec Lansing 2021 speakers located directly below the screen. Visual stimuli were projected to a 3.9 by 2.6 ft area of the projection screen. Audio stimuli were presented at 65 dB, +/– 5 dB.

Presentation of the stimuli and recording of participant responses were controlled by the experimenter from behind a black curtain that extended across the entire height and width of the room behind the projection screen, completely blocking the apparatus from view of the participants. Participant responses were recording using a Sony Digital8 Handycam whose lens protruded inconspicuously through a small hole in the black curtain, 2 inches below the projection screen. Videos of participants were captured digitally on a Macintosh G7 laptop computer using the iMovie program and in analog on a Samsung tv/vcr combo. Figure 5.3 presents an illustration of the configuration of the testing apparatus.

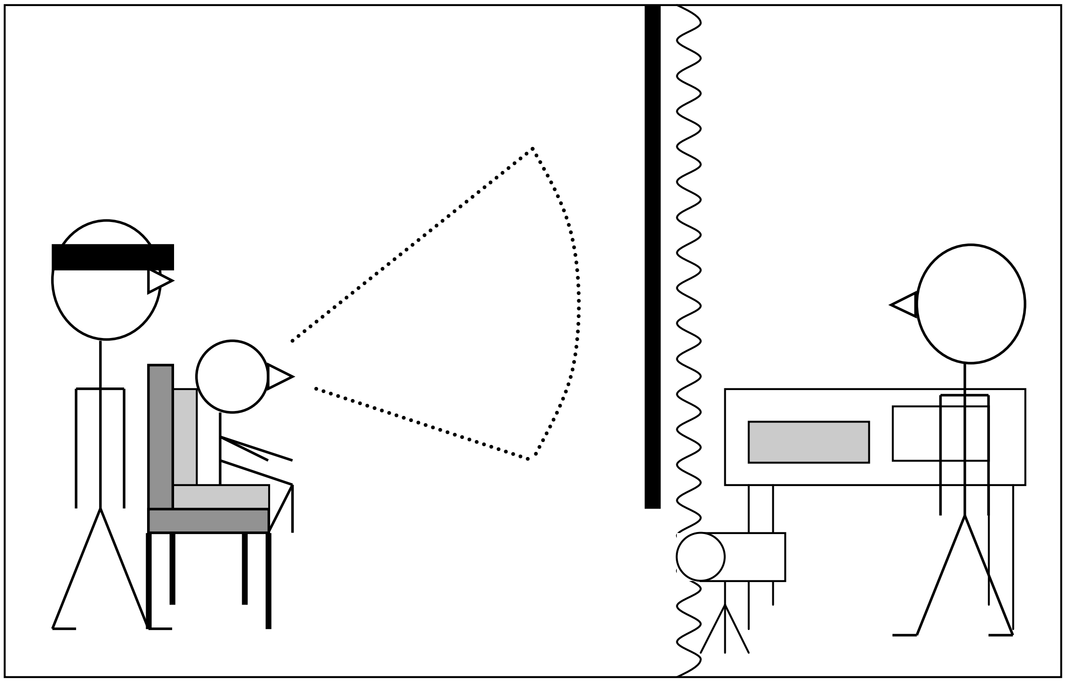

***Figure 5.3*. Configuration of the testing apparatus for 2-year-olds.**

5.4.2 Adults

Stimuli were presented to adult participants in a dimly lit 9 by 10.5 ft room on a 60-inch Sony rear-projection television set situated approximately 6 ft from the participants. Presentation of the stimuli was controlled using a Sony Digital8 Handycam located next to the television in the testing room: the experimenter left the room after starting the stimulus video and returned when it was over.

5.5 Procedure

5.5.1 Children

Upon entering the waiting area, children and parents were greeted and given a brief description of the experimental procedure. The experimenter played with children in the waiting area to give them time to become comfortable with the environment, and during this time (usually around 20 min), accompanying parents were asked to sign consent forms for the study and to fill out language questionnaires, including the MacArthur Communicative Development Inventory (Fenson et al. 1993). When both the child and the parent appeared to be at ease with the situation, the experimenter led them to the testing room described in section 5.4.1.

Children were tested individually,[26] seated in a booster chair facing the projection screen, and their attention to the stimuli was recorded using a digital video camera situated just below the projection screen. In most cases, each child was accompanied by a parent who either stood behind the child or was seated just behind and to the left of the child's chair (Figure 5.3). To avoid fuss-out, some children (16%) were seated on their parent's lap. Parents were asked to

[26] Except in the case of twins, who were often tested at the same time to minimize risk of fuss-out.

refrain from talking or offering nonverbal encouragement while in the testing room. Children whose parents did not adhere to this request were excluded from the analysis.

5.5.2 Adults

Adult participants were also tested individually, seated in a chair facing the television set. No video record was made of adult responses; instead, they were asked to record their choices for extension of the novel verbs by circling “left” or “right” on a prepared answer sheet. The left and right sides of the television set were labeled with signs for reference. After the experiment, adult participants were asked by the experimenter to orally reflect on why they chose the test events that they did.

5.6 Analysis

5.6.1 Children

Data from the MacArthur Inventories were tallied and taken as a measure of parent-reported productive vocabulary for each child. Videos of child participants were coded for direction of visual fixation (left vs. right vs. neither side of the screen) during each frame of the test phases (360 frames per trial, four trials per participant) by research assistants who were not aware of the predicted responses. To confirm accuracy, 23% of the videos were coded by a second research assistant (n = 27, reliability: Cohen’s kappa > .8, percent agreement > 88%). For cases in which we found disagreement between coders (n = 2), a third research assistant provided a tiebreaking code of the data. Data collected in this manner were used to determine overall patterns of looking during the test phase of each trial and mean duration of attention during windows of time linked to the test audio (based loosely on Waxman et al. 2006), as well as to monitor for excessive inattentiveness or biases in looking toward a single side of the projection screen. Trials in which participants attended to the test events for less than 70% (less than 65% for Experiment 3) of the test period were excluded from analysis. Participants with more than two excluded trials were replaced in the design, as were those who exhibited a fixation bias of more than 75% to a single side of the projection screen.

Our analyses of looking time data have been based on the prediction that participants will look longer at test events that match their interpretation of the novel verb presented during familiarization than at those that do not. We performed *t* tests on the data from each experiment to probe for differences in mean visual fixation to the test events across experimental conditions. All reported *p* values are two-tailed.

5.6.2 Adults

Forced-choice answers provided by adult participants were hand-tabulated by the experimenter. We performed *t* tests on the data to compare novel verb extensions across conditions. Oral self-reflections were recorded by the experimenter and compared with quantitative data to gain a clearer understanding of participant responses.

Chapter 6

Encoding Subevents

Recall from the discussion of causative representations presented in Chapters 2 and 3 that results derived from behavioral experimentation and from linguistic description suggest that events of direct causation are decomposable into three distinct subparts. Imagine for example, a causative event in which a boy pumps a bicycle pump that is attached to a garden ornament shaped like a large flower: when he pumps, the flower spins. A decomposition of this event (one of our familiarization events) into its component subparts is given in (91).

(91) $[\underbrace{\text{[boy pumps bike pump]}}_{\text{MEANS}}\ \text{CAUSE}\ \underbrace{\text{[flower spins]}}_{\text{RESULT}}]$

One subpart of this structure specifies the MEANS subevent of the complex causative: i.e., the activity that the agent is engaged in that serves as a means of causing a change of state in the other relevant patient entity. In this case, the MEANS corresponds to the boy's pumping. Another subpart specifies the RESULT subevent: i.e., the change of state undergone by the entity affected by the agent. In this case, the RESULT corresponds to the flower's spinning. The final subpart CAUSE specifies the nature of the relationship between the MEANS and RESULT subevents. Here, it specifies that the boy's pumping directly results in the flower's change of state.

We saw in Chapter 3 that adult speakers can describe a causative event using a single verb that encodes the entire event or using one that only refers to one of the individual MEANS or RESULT subevents. The two experiments described in this chapter were designed to confirm that language learners are aware of the internal structure of the causative representation and that, given the proper set of linguistic and extralinguistic conditions, they are willing to interpret a novel verb associated with this complex structure as a label for one of the subevents. Manipulations to the syntactic frames in which novel verbs were presented and to the options presented to participants at test for extension of the novel verb were carefully controlled to establish the proper set of constraints for learning each meaning.

In English, causative verbs typically appear in transitive frames, as in (92a), in which *spin* labels a causative event that specifies both the specific change of state undergone by the flower and the idea that the boy caused that change of state in some way. (92a) may be paraphrased with the periphrastic causative in (92b), which makes transparent the complex verbal representation associated with causative *spin*.

(92) a. The boy is spinning the flower.

b. The boy is causing the flower to spin.

Because English does not reliably mark causation in the morphology, many causative verbs have homophonous inchoative variants. The inchoative variant of a causative verb unambiguously labels just the result of a given causative event, as in (93), in which *spin* in an unaccusative intransitive frame labels just the change undergone by the flower:

(93) The flower is spinning.

Taking advantage of this reliable cue to verb meaning, we presented novel verbs to participants in unaccusative intransitive frames to draw their attention just to the RESULT subevents of complex causatives.

To draw their attention just to the MEANS subevents of complex causatives, we presented novel verbs in unergative intransitive frames, which specify some activity in which an agent is involved. To describe the event represented in (91) using an unergative intransitive sentence, we might use a verb like *pumping* in (94), which specifies just what the agent is doing without revealing that that activity causes any change of state.

(94) The boy is pumping.

Note that in both of these syntactic frames, the verb is associated with a single argument, but in each case, that argument maps to a different event participant: in the unaccusative, the single argument maps to the patient of a causative event, and in the unergative, the single argument maps to an agent. In order to determine which subevent of a causative is being labeled by an intransitive verb, then, word learners must be sensitive not only to the number of arguments in a given frame, but also to how those arguments map onto event participants. Results reported in Fisher 2002 suggest that in the absence of explicit information about which event participant is specified by the single argument of an intransitive, a mapping of the argument to the patient of a causative event is basic. Fisher finds that 30–month-old children presented with causative events matched with ambiguously intransitive sentences, e.g., the sentence “She’s blicking” matched with an event in which one girl is pulling another girl along the floor on a wheeled dolly, are more likely to associate ambiguous subject pronouns with the patient of the event than with the agent. Presenting verbs in both kinds of intransitive frames has the added benefit, then, of allowing us to investigate the specific kinds of cues that are exploited in syntactic bootstrapping. If we find that word learners interpret verbs in unaccusative and unergative frames as labels for the same subevent, this will suggest that they are basing their judgments about verb meaning strictly on the number of arguments in a given syntactic frame. If, however, they demonstrate differences in their interpretation of verbs presented in these two intransitive frames, this will suggest that they are also aware of the semantic roles played by the single argument in each frame.

We also presented novel verbs to participants in transitive frames. Previous work suggests that 2–year-old children will interpret novel verbs in transitive frames as labels for causative events (e.g., Lidz et al. 2003), but this is not the only possibility. Imagine, for example, an event in which a girl makes a ball bounce up and down by hitting it repeatedly with a tennis racquet. A decomposition of this event (another of our familiarization events) into its component subparts is given in (95):

(95) $[\underbrace{\text{[girl hits ball]}}_{\text{MEANS}}\ \textsc{cause}\ \underbrace{\text{[ball bounces]}}_{\text{RESULT}}]$

To describe this event using a transitive syntactic frame, we could choose a verb that labels either just the girl's activity, as in (96a), or one that that labels the change of state that she causes in the ball, as in (96b), or one that labels the entire causative event, as in (96c).

(96) a. The girl is hitting the ball. MEANS

b. The girl is bouncing the ball. CAUSE + RESULT

c. The girl is dribbling the ball. MEANS + CAUSE + RESULT

Given the fact that the transitive frame does not unambiguously signal any particular meaning, the interpretation of novel verbs presented in transitive frames in these experiments will depend on the biases that each group of word learners bring to the task of word learning.

Finally, it is important to keep in mind that the four causative events we presented to participants in each experiment differed in the directness of the causative relationship between agent and patient. Two of the events involved relatively direct mechanical causation, e.g., the event represented in (95), in which a girl makes a ball bounce by hitting it repeatedly with a tennis racquet, and two involved causation that might be perceived as more indirect, e.g., the event represented in (91), in which a boy makes a flower spin by pumping a bicycle pump that is attached to the flower. As described in Chapters 2 and 3, events of direct and indirect causation tend to be treated differently both conceptually and linguistically (e.g., Shibatani 1976, Wolff 2003), and so we might expect to see differences in the mapping between linguistic and conceptual representations that correspond to this split in type of causation.

The goal of the experiments described in this chapter was to investigate whether language learners would be willing to accept either of the subevents of a complex causative as the meaning of a novel verb: Experiment 1 investigates whether 2-year-olds and adults will accept just the RESULT subevent of a causative representation as the meaning of a novel verb (like unaccusative *spin*), and Experiment 2 investigates whether the same populations will accept just the MEANS subevent of a causative representation as the meaning of a novel verb (like unergative *pump*).

6.1 Experiment 1: RESULT

The goal of Experiment 1 was to confirm that adults and children are willing to interpret a novel verb associated with a causative event as a label for just the result of that event. This experiment is, in part, an attempt to replicate the findings of Bunger & Lidz 2004, in which we demonstrated not only that 2–year-old children do represent complex causative events as having internal structure, but also that when the linguistic input focused children's attention on the result of a given causative event, they interpreted a novel verb as describing that subevent.

6.1.1 Design

Two conditions (as detailed in Table 5.2) were run in a between-subjects design: Unaccusative and Transitive. During a given familiarization phase, participants in both conditions were presented with one of the complex causative events described in Table 5.1, e.g., with a video of a boy causing a flower to spin by pumping a bicycle pump that is attached to the flower. Accompanying this video, participants in the Unaccusative condition were exposed to a novel verb presented in an unaccusative syntactic frame ("Look! The flower is blicking. Do you see the flower blicking?"), and participants in the Transitive condition were exposed to a novel verb presented in a transitive syntactic frame ("Look! The boy is blicking the flower! Do you see the boy blicking the flower?"). After three presentations of the causative event (each paired with two presentations of the novel verb), participants saw a contrast event in which the boy performed a different, noncausative activity involving the flower. Contrast events were accompanied by audio that called attention to the contrast while repeating the novel verb in the appropriate syntactic frame. For the Unaccusative condition, for example, the contrast audio was "Oh no! Now the flower is not blicking. The flower is not blicking." Participants were then presented with one final paring of the causative event and (two repetitions of) the novel verb in the appropriate syntactic frame. Novel verbs were presented a total of 10 times during each familiarization phase (see Appendix 1, Table A2).

During the test phase of the experiment, participants were presented with two new events presented simultaneously on opposite sides of the screen. Each of the test events depicted a single subevent of the causative event presented during familiarization (Table 6.1). In one of the test events, the object underwent the same change of state that it had during familiarization, but without any assistance from the causative agent (Same Result test event). For the familiarization event involving the boy and the flower, then, in the Same Result test event the flower spins on its own while the boy stands idly by. The other test event depicted the agent of the causative event performing the same activity that he had during familiarization, but with that activity not causing a change of state in the familiarized object (Same Means test event). So, in the Same Means test event, the boy pumps the bicycle pump, but the flower does not spin. (A list of the test events that correspond to each familiarization event is available in Appendix 1, Table A3.) The auditory stimulus accompanying these test events directed participants to find the action represented by the novel verb introduced during familiarization. Note that separating the means and result subevents presented during familiarization across test events ensured that neither test event would be more familiar to participants than the other. In addition, this separation has the effect of excluding causation as a possible part of the extended meaning of the novel verb. Thus, this experiment makes it possible to confirm that participants are interpreting the novel verb as a label for the result subevent, and not as a label for result and causation together.

Table 6.1

Test Events for Experiment 1

Phase	**Left side of screen**	**Right side of screen**	**Audio track**
Test	Same Result flower spins (boy does nothing)	Same Means boy pumps (flower does nothing)	Oh look! They're different. Do you see blicking? Do you see blicking? Where's blicking now?

6.1.2 Results and Discussion

The purpose of this experiment was to find out whether participants would be more willing to extend the meaning of the novel verb presented during familiarization to refer to the MEANS or the RESULT subevent of a complex causative. Assuming that the word learners assigned a meaning to the novel verb during the training phase, one of the subevent scenes should provide a better match for the auditory stimulus presented during the test phase, with that match crucially dependent on how the learner interpreted the verb. The relevant question to ask when examining these data, then, is which test event participants are willing to accept as an extension of the meaning of the novel verb presented during familiarization.

In this experiment, a word learner who can encode a label for the result subevent of a causative in a single verb, and who is led to do so by the syntactic frame in which it is presented to them, should be willing to extend the meaning of the novel verb to the test event in which the object undergoes the same change of state that it did in the familiarized causative event: in the case of the causative event involving the boy and the flower, for example, the verb *blick* should mean something like “spin.” When asked to "find blicking," then, these participants should choose the test event in which there is spinning going on.

6.1.2.1 Children. Previous studies have shown that children participating in the preferential looking task tend to look longer at scenes that match some auditory stimulus. Here, we expected them to look longer at the test event that they were willing to label with the novel verb presented during familiarization. Previous work in syntactic bootstrapping has demonstrated, furthermore, that the meaning that 2–year-old children assign to a novel verb is heavily influenced by the syntactic frame in which that novel verb is presented. Given this effect, we expected to find differences in patterns of looking across conditions that reflect the mapping between verb meaning and verb syntax.

The data reported here are from 22 participants (5 boys and 6 girls in the Unaccusative condition, 6 boys and 5 girls in the Transitive condition) ranging in age from 22;1 to 25;16 months;days (mean age 23;27). An additional 10 children were run in the experiment, but were excluded from the analysis for at least one of the following reasons: age (n = 2), parent-reported speech or hearing problems (n = 1), inattention during the test phase for more than 30% on more than two trials (n = 2), experimenter error/equipment malfunction (n = 4), or study design (n = 1).

In all of the experiments reported here, the data for each participant consists of a catalogue of the direction of gaze (i.e., left test event, right test event, neither test event) during each frame (30 frames/s) of the 12 s test periods for each of four trials (360 frames/trial). The test phase begins with a salience period in which participants were given the opportunity to view the two test events before being asked to choose between them ("Oh look! They're different") (loosely modeled after Waxman et al. 2006). After this salience period, the novel verb was repeated three times ("Do you see blicking? Do you see blicking? Where's blicking now?), with the offset of the three repeated words occurring 143, 248, and 299 frames into the test phase. A chart detailing the average proportion of looks toward each test event during every frame of the test period averaged across participants in each condition is available in Appendix 2, Figure A1. Trials in which participants attended to the test events for less than 70% of the test period were excluded from analysis. Participants with more than two excluded trials were replaced in the design.

Table 6.2 provides data on the proportion of looks to the Same Result test event in each condition, averaged across participants. Overall values represent looking during the entire 12 s test phase; Salience values represent looking during a 2 s salience period at the beginning of the test phase; and Word 1 values represent looking during a 2 s window around the offset of the first novel verb in the test audio ("Do you see blicking?"). During the salience period, participants have not yet heard the novel verb repeated, and their pattern of looking provides some information about baseline preferences for the two test events. Looking patterns around the novel verb, on the other hand, provide information about participants' preferences for extension of the novel verb presented during familiarization.

As can be seen from this chart, during the entire 12 s of the test period, participants in both conditions spent just over half of their time looking at the Same Result test event. There were no significant differences between conditions in looking preferences during the Salience window ($t(19) = 1.34$, $p = .19$) or the Word 1 window ($t(15) = -1.38$, $p = .18$). The difference between looking during the Salience and Word 1 windows across conditions approached significance ($t(18) = -1.88$, $p = .07$).

Table 6.2

Proportion of Looks to the Same Result Test Event, Experiment 1

Condition	***n***	**Overall**	**Salience**	**Word 1**
Unaccusative	11	0.53	**0.46**	**0.67**
Transitive	11	0.53	**0.57**	**0.56**

Proportions were calculated for each subject on the basis of the total time spent looking during the test phase, excluding time spent not looking at either test event. The data presented have been averaged across participants in each condition.

To determine which of the test events these 2-year-olds were willing to associate with the novel verb presented during familiarization, we compared looking times during the Salience and Word 1 windows in each condition. Assuming that the Salience window provides a measure of participants' baseline preferences for the two subevents, a significant shift in attention upon hearing the novel verb repeated in the test audio should serve as an indicator of the meaning that participants have associated with that verb. Figure 6.1 provides a graphical depiction of the mean proportion of visual fixation toward the Same Result test event for each experimental condition during the 2 s Salience and Word 1 windows, averaged across participant and trial (error bars represent standard error).

When asked to find the test event that could be labeled by the novel verb presented during the familiarization phase, participants in the Unaccusative condition showed a significant preference for the Same Result test event ($t(10) = 2.18$, $p = .05$). This trend is consistent across three trials: in the trials involving the ball, flower, and light, looking at the Same Result test event was at least 10% greater during Word 1 than during Salience; for the trial involving the tower, looking at the two test events was roughly equal in the two windows. In the Unaccusative condition, 8 of 11 children looked at the Same Result test event for at least 10% more of the Word 1 window than the Salience window (vs. 4 of 11 children in the Transitive condition).

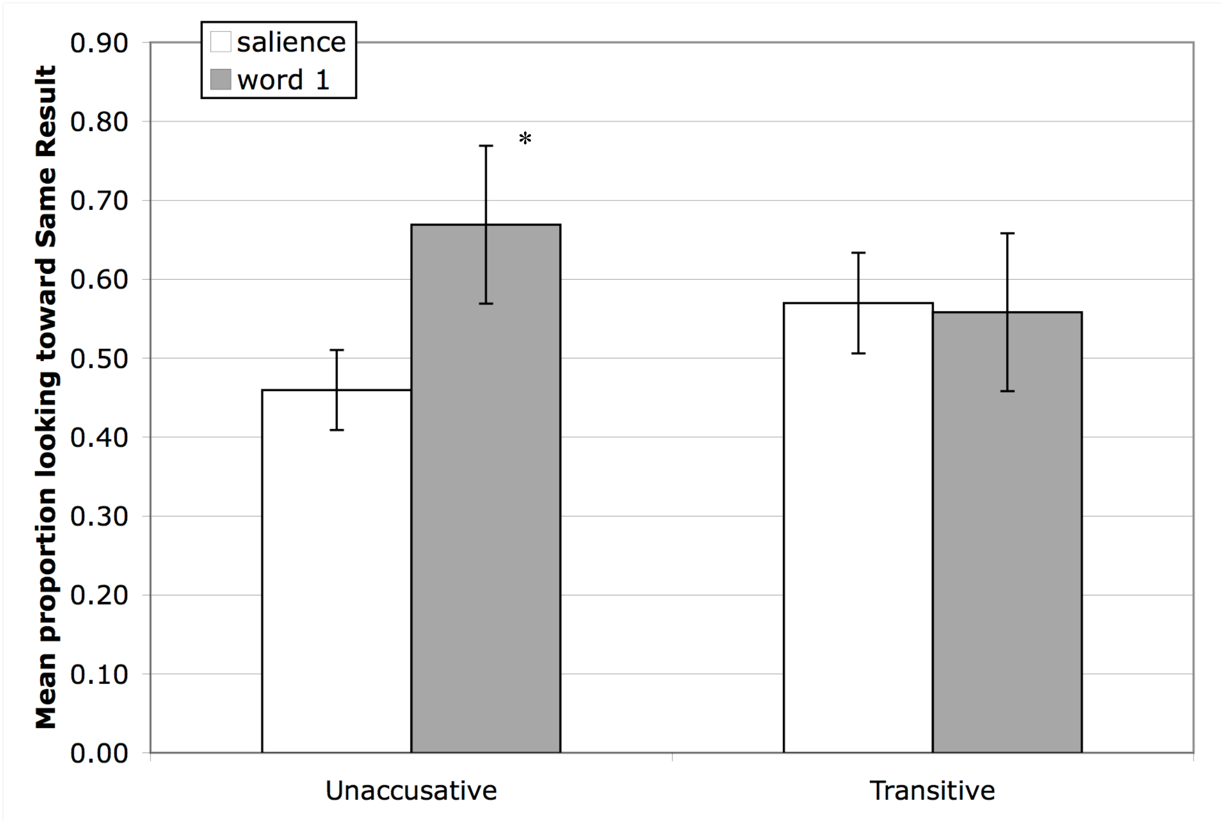

***Figure 6.1*. Mean visual fixation at test, Experiment 1**

* In the Unaccusative condition, mean looking during Word 1 was significantly different from looking during Salience.

Recall that the verb in an unaccusative intransitive frame unambiguously labels the result of a causative event: compare the novel verb input in (97a) with the English verbs in (97b), each of which we know labels just what happens to the patient entity in a given causative event without making reference at all to the means by which that entity's change of state was brought about.

(97) a. The flower is blicking.

b. The flower is spinning/twisting/growing.

The preference for the Same Result test event observed in this condition provides evidence that 2-year-olds are aware of this regular mapping between verb use and verb meaning. Because they heard novel verbs only in the unaccusative intransitive frame during familiarization, they interpreted them as labels for the RESULT subevents of the complex causatives. At test, then, the Same Result test event offers the only option for extension of the novel verb because it is the only test event in which the RESULT subevent is repeated.

Participants in the Transitive condition, on the other hand, showed no significant increase in their preference for either test event when asked to find the referent of the novel verb ($t(10) = -.16$, $p = .87$). This result is not surprising when we consider that, unlike the unaccusative intransitive frame, the transitive frame provides an ambiguous source of input in that the verb that it carries may label either just the means of a causative event, or the result of a causative event, or an entire causative event. In this condition, then, because the input did not provide participants with any unambiguous information about the meaning of the novel verb, it is possible that their lack of preference for either test event reflects their uncertainty about the verb's meaning. Note, however, that we would also expect this pattern of results if these participants interpreted novel verbs in transitive frames as labels for the entire causative event: because neither test event was causative, neither provided a possible option for extension of the novel verb.

Given the lack of significant differences between looking patterns in the Unaccusative and Transitive conditions, however, it is also possible that participants in the Transitive condition were willing to accept the novel verb as a label for the RESULT subevent, but that this interpretation of the data is obscured by their high baseline preference for the Same Result test event. In order to tease apart these possible interpretations of the data, we will need to compare looking patterns in the Transitive condition with those from participants in a No Word condition (which data is currently being collected). If looking during the Salience and Word 1 windows in the Transitive condition is not significantly different from looking in the No Word condition, this will suggest that participants in the Transitive condition did not interpret the novel verb as a label for the RESULT subevent.

An ANOVA analysis including age, sex, productive vocabulary, and proportion looking during Word 1 – Salience reveals that participant sex and productive vocabulary were not significantly correlated with observed differences in looking times (sex: $F(1, 20) = .081$, $p = .78$; productive vocabulary: $F(1, 20) = .057$, $p = .81$). Participant age was significantly correlated with performance, however, such that younger children were more likely than older children to look longer at the Same Result test event during the Word 1 window than the Salience window ($F(1, 20) = 4.26$, $p = .05$). Stepwise regression reveals, moreover, that participant age alone accounts for all of the variance in the data ($r^2 = .25$). We are not concerned that this correlation poses a threat to our analysis. First, recall that choosing to associate the Same Result test event with the novel verb is a possible interpretation supported by the syntactic input in both conditions. Second, note that the average age of participants in the Unaccusative condition (23;16) was lower than that of participants in the Transitive condition (24;6), such that age and condition were covariant. Given this, the observed correlation between participant age and test event preference only serves to strengthen our claim that children of this age can use cues from syntax to determine the meaning of a novel verb.

6.1.2.2 Adults. Previous studies using the Human Simulations Paradigm (e.g., Gillette et al. 1999) have revealed that adults, like children, can use cues from the syntactic frame in which a novel verb appears to guide their hypotheses about the verb's meaning. Developmental studies have shown, however, that adult word learners may also make use of learned language-specific lexicalization biases to inform verb learning. It remains to be determined, then, whether the kinds of syntactic cues we provide to word learners in this study will lead adults and children to postulate the <u>same</u> meanings for novel verbs. In order to investigate this question, we presented 18 adults (6 per condition) with the same stimuli presented to our 2–year-old participants, and asked them to decide which of the two test events could be labeled by the novel verb presented during familiarization. The data for each participant consists of a single forced-choice answer (left vs. right test event) for each of four trials.

Table 6.3 provides data on the proportion of adult participants who chose to extend the meaning of the novel verb to include the Same Result test event rather than the Same Means test event in each experimental condition. Adults in the No Word condition demonstrated a significant preference for the Same Result test event ($t(5) = 7.90$, $p = .0005$ vs. chance), perhaps reflecting a general conceptual bias for the ends of events over the beginnings (e.g., Lakusta & Landau 2005, Regier 1996). The data reveal, furthermore, that like 2-year-olds, these adults interpreted a novel verb in an unaccusative intransitive frame as a label for the RESULT subevent of the familiarized causative: across trials, every adult participant in the Unaccusative condition chose to extend the meaning of novel verbs to include Same Result test events rather than Same Means test events.

Unlike the 2-year-olds, however, the adult participants chose to extend all novel verbs in transitive frames to include the Same Means test event rather than the Same Result test event. This result suggests that these adults interpreted novel verbs in transitive frames as labels for a noncausative agentive activity, so that the novel verb *blicking* in the transitive sentence (98a) would be interpreted as something like *pumping* in (98b).

(98) a. The boy is blicking the flower.

b. The boy is pumping the flower.

Statistical analysis using the Tukey-Kramer *t* test revealed that differences between Unaccusative vs. Transitive and Transitive vs. No Word responses were significant ($\sqrt{2}q^* = 3.68$, $p < .05$). There were no effects of trial order or type (all $F(2, 71) = .116$, $p > .73$).

Table 6.3

Proportion of Adults Choosing the Same Result Test Event, Experiment 1

		Trial				
Condition	***n***	Ball	Tower	Light	Flower	Mean
No Word	6	1	1	0.83	0.83	**0.92***
Unaccusative	6	1	1	1	1	**1***
Transitive	6	0	0	0	0	**0***

* Mean proportion of test event choices is significantly different from chance (0.5).

6.2 Experiment 2: MEANS

The goal of Experiment 2 was to confirm that adults and children are willing to interpret a novel verb associated with a causative event as a label for just the MEANS of that event. We designed this study with the hope that the unergative intransitive frame would trigger this interpretation. Note, however, that unlike verbs in unaccusative intransitive frames, which invariably label the result of a causative event, verbs in unergative intransitive frames don't always label the means. When describing our causative event involving the boy and the garden flower with an unergative intransitive sentence, we might use a verb like *pumping* in (99a), which specifies just what the agent is doing without revealing that that activity causes any change of state. However, we also have the option to use a verb like *playing* in (99b), which seems to describe the entire event (but without specifying that it is a causative event).

(99) a. The boy is pumping.

b. The boy is playing.

In light of this ambiguity in the syntactic input, we presented only very limited options for extension of the novel verb to test events in order to make the task as simple as possible for our word learners.

6.2.1 Design

The familiarization phase of Experiment 2 was identical to that described for Experiment 1, with participants familiarized to causative events labeled by novel verbs. Two conditions (as detailed in Table 5.2) were run in a between-subjects design: Unergative and Transitive. During the test phase of the experiment, participants were presented with two new events, presented simultaneously on opposite sides of the screen, both of which depicted the agent of the familiarized causative engaged in some noncausative activity (Table 6.4). In one of the test events, only the MEANS subevent of the familiarized causative was repeated (Same Means test event). For the familiarization event involving the boy and the flower, for example, in the Same Means test event the boy pumps a bicycle pump that is attached the flower, but the flower does not spin. The other test event depicted the agent making some new kind of direct contact with the patient that could serve as a potential cause of the change of state seen in the familiarization event (New Means test event). So in the New Means test event involving the boy and the flower, the boy has set aside the bicycle pump, and instead he hits the flower petals with his hand as though to set them spinning, but the flower does not spin. (A list of the test events that correspond to each familiarization event are available in Appendix 1, Table A5.) As in Experiment 1, the auditory stimulus accompanying these test events directed participants to find the action represented by the novel verb introduced during familiarization.

Table 6.4

Test Events for Experiment 2

Phase	**Left side of screen**	**Right side of screen**	**Audio track**
Test	Same Means boy pumps (flower does nothing)	New Means boy hits flower with his hand (flower does nothing)	Oh look! They're different. Do you see blicking? Do you see blicking? Where's blicking now?

Given the vagueness of the cues provided by the linguistic input in this experiment, we chose this particular set of simple test events in an attempt to make it make it as easy as possible for participants to map novel verbs to MEANS (sub)events. Note that in neither of the test events does the object affected in the causative event undergo a change of state: controlling the event features in this way has the effect of excluding the CAUSE and RESULT subevents as possible parts of the meaning of the novel verb. Moreover, while it is the case that the Same Means test event may be perceived as more familiar than the New Means test event (because it is the only test event in which a subevent of the familiarized causative is repeated), differences in performance across conditions will allow us to confirm that novel words were mapped to test events on the basis of information from the syntactic input and not merely by choosing the most familiar test events. Together, these manipulations of the event features make it more likely that participants who choose the Same Means test event are actually interpreting the novel verb as a label for the MEANS activity presented during familiarization and not as a label for some more abstract level of event description.

6.2.2 Results and Discussion

The purpose of this experiment was to find out whether participants would be willing to interpret a novel verb associated with a causative event as a label for just the MEANS subevent of the complex causative. As in Experiment 1, the relevant question to ask when examining these data is which test event participants were willing to accept as an extension of the meaning of the novel verb presented during familiarization.

In this experiment, a language learner who can encode a label for the MEANS subevent of a causative in a single verb, and who is led to do so by the syntactic frame in which it is presented to them, should be willing to extend the meaning of the novel verb to include the test event in which the causative agent engages in the same activity that he performed during familiarization: in the case of the causative event involving the boy and the flower, for example, the verb *blick* should mean something like “pump.” When asked to "Find blicking," then, these participants should choose the test event in which the boy is pumping.

6.2.2.1 Children. The data reported here are from 24 participants (6 boys and 6 girls in each conditions) ranging in age from 22;8 to 25;27 months;days (mean age 24;16). An additional 10 children were run in the experiment, but were excluded from analysis for at least one of the following reasons: age (n = 1), language background (n = 1), unwillingness to complete the experiment (n = 2), inattention during the test phase for more than 30% on more than two trials (n = 3), interference from accompanying parent (n = 1), or study design (n = 2). Trials in which participants attended to the test events for less than 70% of the test period were excluded from analysis.

As in the previous experiment, we expected 2-year-olds to look longer at the test event that they were willing to label with the novel verb presented during familiarization when the test audio directed them to find that event. Table 6.5 provides data on the proportion of looks to the Same Means test event in each condition, averaged across participants. Overall values represent looking during the entire 12 s test phase; Salience values represent looking during a 2 s salience period at the beginning of the test phase; and Word 1 values represent looking during a 2 s window around the offset of the first novel verb in the test audio (“Do you see pimming?”). During the salience period, participants have not yet heard the novel verb repeated, and their pattern of looking provides some information about baseline preferences for the two test events. Looking patterns around the novel verb, on the other hand, provide information about participants’ preferences for extension of the novel verb presented during familiarization.

As can be seen from this chart, during the entire 12 s test period, participants in both conditions spent approximately half of their time looking at the Same Means test event. (A chart detailing the average proportion of looks toward each test event during each frame of the 12 s test period is available in Appendix 2, Figure A2.) Differences across conditions in looking during the Salience window approached significance, with participants in the Unergative condition looking longer at the New Means test event than participants in the Transitive condition ($t(21) = 1.94$, $p = .06$). There were no significant difference between conditions in looking preferences during the Word 1 window ($t(22) = -.68$, $p = .50$). The difference between looking during the Salience and Word 1 windows across conditions was not significant ($t(21) = -1.70$, $p = .10$).

Table 6.5

Proportion of Looks to the Same Means Test Event, Experiment 2

Condition	*n*	Overall	Salience	Word 1
Unergative	12	0.49	**0.39**	**0.51**
Transitive	12	0.51	**0.53**	**0.45**

Proportions were calculated for each subject on the basis of the total time spent looking during the test phase, excluding time spent not looking at either test event. The data presented have been averaged across participants in each condition.

To determine which of the test events these 2-year-olds were willing to associate with the novel verb presented during familiarization, we compared looking times during the Salience and Word 1 windows in each condition. Assuming that the Salience window provides a measure of participants' baseline preferences for the two subevents, a significant shift in attention upon hearing the novel verb repeated in the test audio should serve as an indicator of the meaning that participants have associated with that verb. Figure 6.2 provides a graphical depiction of the mean proportion of visual fixation toward the Same Means test event for each experimental condition during the 2 s Salience and Word 1 windows, averaged across participant and trial (error bars represent standard error).

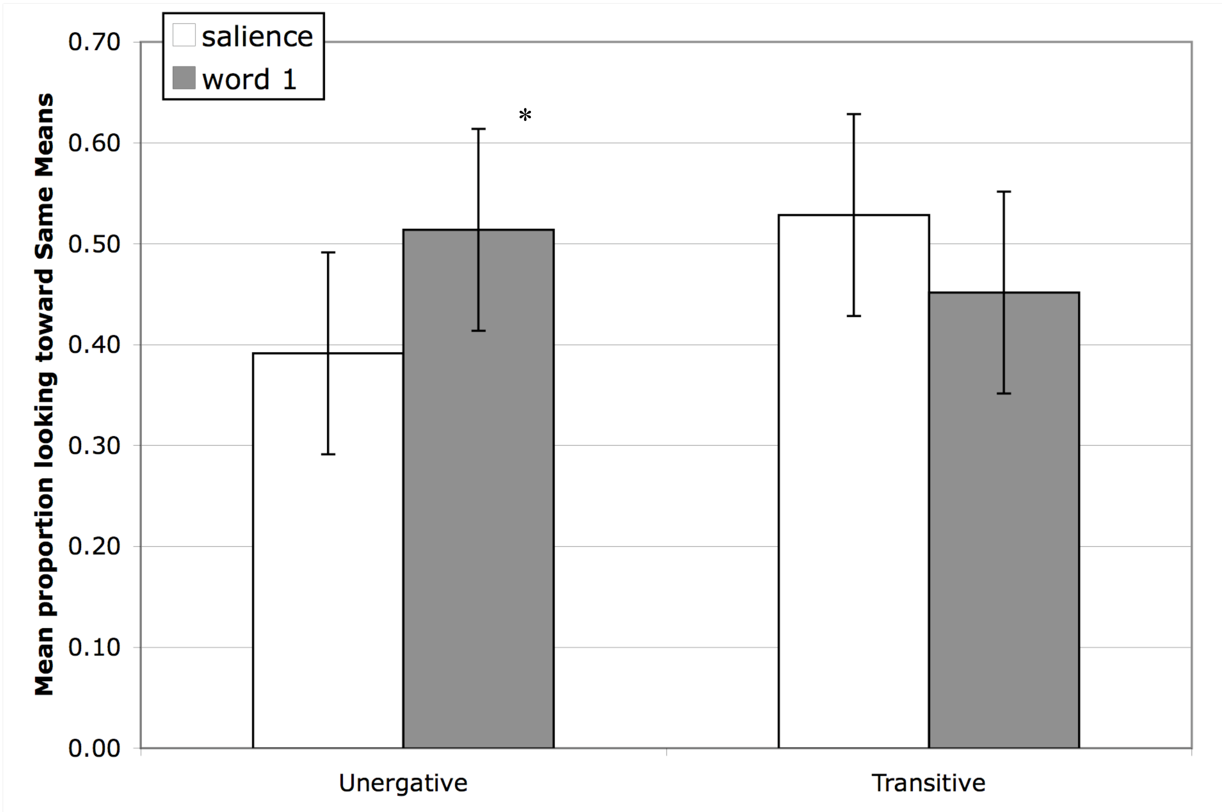

***Figure 6.2*. Mean visual fixation at test, Experiment 2**

* In the Unergative condition, mean looking during Word 1 is significantly different from looking during Salience for familiarization events involving indirect causation.

When asked to find the test event that could be labeled by the novel verb presented during the familiarization phase, participants in the Unergative condition showed a preference for the Same Means test event. Although this preference was consistent across three of the four trials (for the trials involving the ball, flower, and light, looking at the Same Means test event was at least 10% greater during Word 1 than during Salience; for the trial involving the tower, looking at the two test events was roughly equal in the two windows), the trend reached significance only for trials in which the familiarization events had involved indirect causation (indirect (light, flower): $t(11) = -2.54$, $p = .028$; direct (ball, tower): $t(11) = .256$, $p = .8$). Table 6.6 presents a breakdown of looking patterns in the Unergative condition by type of causative event. To make sense of this split, it is useful to consider what the differences between the two test events actually were for each type of causative event.

Table 6.6

Proportion of Looks to the Same Means Test Event by Type of Causative Event, Experiment 2, Unergative Condition

Type of causation	**Overall**	**Salience**	**Word 1**
Direct	0.52	**0.47**	**0.50**
Indirect	0.42	**0.31**	**0.52***

*Significantly different from Salience.

Recall that in all of the New Means test events, the agents abandoned the instruments they had been using in the familiarization events and made direct contact with the objects that had been affected in the causative event. For both kinds of causative events, then, the differences between the two test events involved a difference in the configuration of the participants of the causative event and their relationship to each other. For the trial involving the boy and the flower (one of the more indirect causatives), for example, in the Same Means test event, the boy moves a bicycle pump up and down, and in the New Means test event he hits a flower. For causative events involving direct causation, however, the perceptual differences between the two test events were rather subtle. For the trial involving the girl and the ball, for example, in the Same Means test event, the girl moves her arm up and down to hit the ball with a tennis racquet, and in the New Means test event she moves her arm up and down to hit the ball with her hand. In both of these test events, then, the girl is moving in a similar manner and along an almost identical path, and in both events she makes relatively direct contact with the ball. Given these similarities, it is likely that the 2-year-olds who participated in this study did not perceive a difference between the two test events provided for the more direct causative events, making it impossible for them to choose between them.

We could test this hypothesis with a change-blindness study, first habituating participants to the causative events presented as familiarization events in these studies and then at test, presenting them with new causative events in which the MEANS subevent has been changed as in the New Means test events in this experiment. According to this design, the habituation events would differ in the directness of the causative relationship between agents and patients, but the dishabituation events would all involve direct causation. For example, participants who are habituated to the (direct) causative event in which the girl makes the ball bounce by hitting it with the tennis racquet will be presented at test with a causative event in which the girl makes the ball bounce by hitting it with her hand, and participants habituated to the (indirect) causative event in which the boy makes the flower spin by pumping the bicycle pump will be presented at test with a causative event in which the boy makes the flower spin by hitting it with his hand. If it is the case that the difference between means of causation is relevant to event representation only when it corresponds to a change in the directness of the relationship between the event participants, then participants habituated to events involving direct causation (e.g., the event involving the girl and the ball) shouldn't dishabituate to these changes in the MEANS subevent, but those habituated to events involving indirect causation (e.g., the event involving the boy and the flower) should dishabituate.

To sum up what we can conclude on the basis of looking preferences in the Unergative condition, then, recall that the verb in an unergative intransitive frame labels some activity that an agent is involved in: compare the novel verb input in (100a) with the English verb in (100b), which we know labels just what the boy is doing without making explicit reference to any change of state that might be caused by that activity.

(100) a. The boy is blicking.

b. The boy is pumping.

The preference for the Same Means test event observed in this condition provides evidence that 2-year-olds are willing to interpret verbs in this frame as a label for the MEANS subevent of a complex causative.

This preference for the Same Means test event also sheds some light on the nature of the syntactic cues 2-year-olds use to inform their hypotheses about verb meaning. Specifically, it demonstrates that by this age, children use specific information about the semantic role of the participants in an event to determine which subpart of a complex event is labeled by a novel verb. If our 2-year-olds had been using nothing more than the number of arguments in the input frame to drive their interpretation of novel verbs in this study, we would have expected participants in the Unergative condition, like those presented with novel unaccusative intransitive verbs in Experiment 1, to map these one-argument verbs onto the RESULT subevent. In this case, because the RESULT subevent was not repeated in either test event, neither should have provided a suitable match, and participants in this condition should have performed at chance. Instead, our participants mapped unergative intransitive verbs onto the MEANS subevent of the complex causative, demonstrating that they were aware of the mapping between the subjects of the input sentences and the agents of the causative events.

Note also that while looking preferences in the Unergative condition do not appear to rise above chance, this lack of absolute proportion of looking does not pose a serious threat to our analysis. Recall that looking patterns during the Salience window suggest that participants in this condition have a novelty preference for the New Means test event, perhaps because the linguistic input helped them to focus on the MEANS subevent of the causative presented during familiarization. In order to choose the subevent that matches their interpretation of the novel verb then, these participants must first overcome their novelty preference. Given this limitation, comparison of looking during the Word 1 window to the baseline preference established during the Salience window is more important than absolute proportions of looking. In the Unergative condition, 7 of 12 children looked at the Same Means test event for at least 10% more of the Word 1 window than the Salience window (vs. 3 of 12 children in the Transitive condition).

Finally, as in Experiment 1, participants in the Transitive condition showed no significant increase in their preference for either test event when asked to find the referent of the novel verb ($t(11) = -.85$, $p = .41$). Again, this result is expected if these 2-year-olds are biased to map novel verbs in transitive frames onto causative events. In this case, because neither of the test events was causative, neither provided a suitable match for the verb. A bias to interpret transitive verbs as causative may also explain why participants in this condition didn't demonstrate a novelty preference during the Salience window: because the input biased them to look for a causative event, both noncausative test events were equally novel.

Finally, an ANOVA analysis including age, sex, productive vocabulary, and proportion looking during Word 1 – Salience reveals that in this experiment, participant age ($F(1, 21) = 5.69$, $p = .58$) and productive vocabulary ($F(1, 21) = .43$, $p = .52$) were not significantly correlated with performance. Participant sex was significantly correlated with performance, however, such that across conditions male participants were more likely, on average, than female participants to demonstrate a preference for the Same Means test event during the Word 1 window ($F(1, 21) = .31$, $p = .03$).

6.2.2.2 Adults. We presented 18 adults with the same stimuli (6 in each experimental condition) presented to our 2–year-old participants, and asked them to decide in a forced-choice task which of the two test events could be labeled by the novel verb presented during familiarization.

Table 6.7 provides data on the proportion of adult participants who chose to extend the meaning of the novel verb to include the Same Means test event rather than the New Means test event in each experimental condition. Adults in the No Word condition demonstrated a numerical but nonsignificant preference for the Same Means test event ($t(5) = 1.58$, $p = .17$ vs. chance), perhaps due to a familiarity preference. In both of the Unergative and Transitive conditions, participants chose to extend all novel verbs to include the Same Means test event. There were no effects of trial order or type (all $F(2, 71) = .116$, $p > .35$).

These data reveal, then, that like 2-year-olds, these adults interpreted a novel verb in an unergative intransitive frame as a label for the MEANS subevent of the familiarized causative: across trials, every adult participant in the Unergative condition chose to extend the meaning of novel verbs to include Same Means test events rather than New Means test events. Moreover, as in Experiment 1, adults in this study interpreted novel verbs in transitive frames as labels for the activity of the causative agent, so that the novel verb *blicking* in the transitive sentence (101a) was interpreted as something like *pumping* in (101b).

(101) a. The boy is blicking the ball.

b. The boy is pumping the ball.

Table 6.7

Proportion of Adults Choosing the Same Means Test Event, Experiment 2

		Trial				
Condition	***n***	Ball	Tower	Light	Flower	Mean
No Word	6	0.83	0.83	0.83	0.5	**0.75**
Unergative	6	1	1	1	1	**1***
Transitive	6	1	1	1	1	**1***

* Proportion of test event choices is significantly different from chance (0.5).

The fact that the preference for the Same Means test event held for trials involving both direct and indirect causation suggests that these adult language learners were sensitive to event features overlooked by the 2-year-olds, viz., the presence or absence of an instrument. Participant self-reflections confirm this conclusion: all adults questioned about how they had chosen between the test events provided some variation of the answer that they had selected the one in which "the actor was still using the instrument in the same way." [27]

6.3 General Discussion

Our goal in the experiments described in this chapter was to begin to investigate the range of meanings that 2–year-old children and adults will encode as single verbs labeling complex causative events and what conceptual and linguistic constraints guide their hypotheses about those meanings. Specifically, we wanted to confirm that, given the proper set of linguistic and extralinguistic circumstances, these two groups of word learners would be willing to encode just the RESULT subevent as the meaning of a novel verb labeling a complex causative or just the MEANS subevent. Both of these meanings correspond to possible linguistic representations, and there are syntactic frames that regularly signal each of them: unaccusative and unergative intransitive frames, respectively. In order to present the proper contexts for inferring these meanings, we manipulated both the syntactic frames in which novel verbs were presented and the subparts of the familiarized causative event that were repeated in test events.

The pattern of results reported here provides further evidence that 2-year-olds can use information from the syntactic frames in which novel verbs appear to guide their hypotheses

[27] Quotation taken from participant self-assessments.

about what those verbs mean. In both experiments, the pattern of verb extension observed during the test phase was different for novel verbs presented in intransitive and transitive frames. Specifically, participants in both experiments were willing to map intransitive verbs, but not transitive verbs, onto individual subevents of the complex causative familiarization events. These results are consistent with the claim that 2-year-olds interpret novel verbs in transitive frames as labels for causative events: in both experiments, 2-year-olds who learned novel verbs in transitive frames were not willing to extend them to either individual subevent of the causative.

The results of these two experiments strongly suggest, moreover, that children are using more than just the number of arguments associated with a novel verb to inform hypotheses about its meaning. In Experiment 1, 2-year-olds who learned a novel verb label for a causative event in an intransitive frame that specified just the patient of the familiarized causative event (i.e., in an unaccusative intransitive frame) preferred to extend it to label a test event that corresponded to just the RESULT subevent of the complex causative (without any external causation) over a test event that corresponded to just the MEANS subevent of the complex causative (without any resulting change of state). And in Experiment 2, 2-year-olds who learned a novel verb label for a causative event in an intransitive frame that specified just the agent of the familiarized causative event (i.e., in an unergative intransitive frame) preferred to extend it to label a test event that corresponded to just the MEANS subevent of the complex causative over a test event in which the agent interacted with the patient entity in a new way.

Recall from the discussion of linguistic representations in Chapter 3 that not all intransitive frames are created equal: specifically, the surface subject of an unergative intransitive sentence is underlyingly an external argument of the verb, but the surface subject of an unaccusative intransitive is an internal argument of the verb. In the case of intransitives, then, the challenge for verb learning is more complex than accomplishing a simple structural alignment of a one-argument syntactic frame with an event representation (e.g., Fisher 1996, 2002): learners also have to map the surface syntax to one of two different underlying grammatical structures. I would like to argue that not only were our 2–year-old learners associating one-argument verbs that specified different event participants with different subparts of the complex causative familiarization events, but that they also used information about the semantic roles played by those event participants to link the different kinds of intransitive event descriptions to different syntactic structures.

As detailed in Chapter 2, it is well established that children even younger than our word learners are not only sensitive to causal relationships between event participants (e.g., Leslie 1982), but that they are able to distinguish between the relevant participants in a causative event. Cohen and Oakes (1993) demonstrate, for example, that 10–month-old children notice changes to the event participant that causes a launching event but not to the event participant undergoing the change of state. It has been argued that adults use some kind of linking rules to map semantic roles like causer and undergoer (or agent and patient/theme) to their grammatical roles (e.g., Baker 1997, Jackendoff 1990, Levin & Rappaport Hovav 1995, Pinker 1989, Snedeker & Gleitman 2004). Levin & Rappaport Hovav (1995), for example, offer the following rules for mapping causers to external arguments (p.135) and undergoers to internal arguments (p. 146):

(102) a. Immediate Cause Linking Rule

The argument of a verb that denotes the immediate cause of the eventuality described by that verb is its external argument.

b. Directed Change Linking Rule

The argument of a verb that corresponds to the entity undergoing the directed change described by that verb is its direct internal argument.

Following Pinker (1989) and Snedeker & Gleitman (2004), I would like to claim that something like these linking rules, which are universal, as far as is currently known, across the world's languages, is part of the preprogrammed set of assumptions that children bring to the task of verb learning: i.e., children come predisposed to map certain semantic roles to certain grammatical roles. Here, we see that in the case of causative events, they map the causer to the external argument (i.e., subject) of a one-argument verb and the undergoer to the internal argument (i.e., object) of a one-argument verb.[28]

Recall that in our experiments, 2-year-olds interpreted novel verbs in unaccusative intransitive frames as labels for the RESULT subevent of a complex causative, and novel verbs in

[28] It is likely that young children (and adults) assign semantic roles on the basis of characteristics like the animacy of a given event participant or its volitional involvement in the event under consideration, such that animate, volitional entities are assumed to be agents and inanimate entities are assumed to be patients (perhaps calculated on the basis of something like Dowty's Argument Selection Principle; Dowty 1991, see also Zaenen 1993). Note, however, that animacy is not on its own an absolute determinant of semantic role. The results of act-out tasks (e.g., Naigles et al. 1992) demonstrate that young children are willing to map animate entities onto the single argument of unaccusative intransitive verbs like *The elephant fell*, i.e., to recognize that they are the undergoers of the event. Likewise, in the case of a launching event involving two inanimate objects, we would expect children to identify the inanimate launcher as the causer of the event.

unergative intransitive frames as labels for the MEANS subevent of a complex causative. Note that if participants in these experiments had not been aware of the mapping between the single argument of each of these classes of intransitive verbs and the thematic roles that they represented, the patterns of looking in both experiments would have been drastically different. If children of this age were subject to some agency bias that led them to assume that the single argument of an intransitive maps to the agent of some event, then participants in the Unaccusative condition of Experiment 1 should have chosen to extend novel verbs to refer to the Same Means test event rather than the Same Result test event. If, on the other hand, as suggested by results reported in Fisher 2002, children of this age are biased to assume that the single argument of an intransitive maps to the patient entity in causative events, participants in the Unergative condition in Experiment 2 should have performed at chance, because the (sub)event in which the patient entity had an active role was not repeated in either test event. The fact that our 2–year-old participants mapped event agents to the single argument of unergative verbs and event patients to the single argument of unaccusative verbs demonstrates, then, that children of this age use more than just the number of arguments in an input frame to make inferences about the meaning of a novel verb.

Our results show that adults, too, make use of syntactic cues to inform word learning. These experiments demonstrate that, like 2-year-olds, adult language learners map novel verbs presented in unaccusative intransitive frames to the RESULT subevent of a complex causative and novel verbs presented in unergative frames to the MEANS subevent of a complex causative. Unlike 2-year-olds, however, they do not appear to be biased to interpret verbs in transitive frames as causatives. Instead, adults in both of these experiments mapped novel verbs presented in transitive frames onto the MEANS subevent of the familiarization events. This finding sheds some light on the different heuristics that guide word learning in these two populations: specifically, it suggests that adults have gained some knowledge on the basis of their experience with the target language that draws them away from their inherent bias to interpret transitive verbs as causative.

These experiments also provide support for previous reports of the event features that are relevant for the mapping between conceptual and linguistic event representations and reveal interesting facts about the kinds of flexibility that language learners allow when encoding the semantic content of verb representations. In the Unergative condition of Experiment 2, we found a split in our 2–year-old participants' awareness of changes to the MEANS subevent of causatives that corresponds directly with previously reported differences in the conceptualizations of direct and indirect causal chains (e.g., Wolff 2003). Here, the degree of closeness between agent and patient in familiarization events affected whether 2-year-olds encoding MEANS subevents in a novel verb noticed a change in the agent's activity. When the change brought the agent and the patient into closer contact, 2-year-olds only accepted the original MEANS subevent as the meaning of the novel verb. As long as the degree of contact between the two event participants stayed the same, however, 2-year-olds appeared to be flexible in how precisely the means activity had to match the familiarization event: i.e., they showed no preference for extension of the novel verb between a test event depicting the agent's original activity and one in which the agent's activity changed, suggesting that this change was not linguistically relevant. Adult participants did not exhibit this flexibility in encoding verb meanings, suggesting again that the knowledge and strategies that they bring to the task of word learning differ in subtle ways from the biases that guide younger learners.

In both of the experiments reported in this chapter, we presented word learners with complex causative events matched with novel verbs that labeled an individual subevent and asked them at test to locate the subevent they had associated with the novel word. In the experiments I will describe in Chapter 7, we were interested in finding out what would happen if we led word learners to interpret novel verbs as labels for entire causative events and then asked them to accept changes to one of the causative subparts. Our goal in these experiments was to investigate how these populations of word learners would resolve conflicts between hypothesized verb meanings and new information provided by the extralinguistic context. The degree of flexibility that learners will permit in encoding the subparts of the causative representation will be informative about the precision required in mapping conceptual event representations to linguistic structures.

Chapter 7

Encoding Causatives

In Experiments 1 and 2, we presented adults and 2-year-olds with causative events labeled with novel verbs and asked them to extend those verbs to label one of the causative subevents. The results of these experiments demonstrate that both groups of word learners are aware of the internal structure of causative events and that they are willing to associate novel verbs with just the RESULT subevent of a complex causative or just the MEANS subevent. Results from Experiment 2 suggest, moreover, that 2-year-olds at least will allow some flexibility in the identity of the MEANS subevent that they associate with novel verbs, such that changes to the MEANS subevents seem to be acceptable as long as they preserve the closeness of the association between the causative agent and patient modeled during familiarization.

What we didn't know, however, was how exactly how widespread this flexibility is: i.e., how strictly verb representations have to match the event with which they are first associated, what kinds of changes to events labeled with single verbs are acceptable, and how those judgments change as a learner gains more experience with her language and the world. Our goal in the experiments described in this chapter was to probe the degree of flexibility that adult and 2–year-old word learners will allow in the semantic identity of the subevents of causative events associated with single novel verbs and what kinds of changes they will accept. Experiment 3 investigates whether these groups of learners will accept changes to the MEANS subevent of a causative representation labeled with a single verb, and Experiment 4 investigates whether the same populations will accept changes to the RESULT subevent.

Again, to establish the proper set of constraints for learning each meaning, we carefully controlled the syntactic frames in which novel verbs were presented and the options presented to participants at test for extension of the novel verb in each experiment. To draw attention to causative events during familiarization, we presented novel verbs in transitive frames, and to draw attention away from causative events, we presented novel verbs in unaccusative (Expt. 3) and unergative (Expt. 4) intransitive frames, which we know, on the basis of Experiments 1 and 2, both populations of language learners will interpret as labels for subevents of complex causatives.

Because our goal was to investigate what happens when learners are asked to extend novel verbs to events other than those with which they were first associated, neither of the event options presented to participants at test precisely matched the familiarized causative. The changes we made to test events were designed to pit the allure of matches in perceptual event features against matches in conceptual features of event representations to find out which kind of event feature provides the most important kind of information for event categorization and labeling.

The results of these experiments will shed light on the heuristics that our two groups of word learners use to resolve conflicts between hypothesized verb meanings and new information from the extralinguistic context and how those strategies change as they gain more experience with the linguistic and extralinguistic input. If we find that word learners are willing to accept changes in conceptual event features (i.e., the kind of event category or number of events associated with a given verb) but not in the specific identity of causative subevents, this will suggest that it is perceptual features that guide the categorization and labeling of events. If, however, our word learners accept changes in the specific identity of causative subevents that still correspond to possible mappings between conceptual and linguistic event representations, this will provide strong evidence in support of the claim that verb representations are abstract in nature, and not tied to the specific events with which they were first associated.

7.1 Experiment 3: Changing the MEANS

The goal of Experiment 3 was to explore children's flexibility in encoding the semantic content of the MEANS subpart of a complex causative. Participants were first familiarized to a causative event labeled with a novel verb, and then at test, they were asked to extend the novel verb to one of two events in which subparts of the familiarized causative (either the MEANS subevent or the causal connection between subevents) had been modified.

7.1.1 Design

The familiarization phase of Experiment 3 was identical to that described for Experiments 1 and 2, with participants familiarized to causative events labeled by novel verbs. Recall that the four causative events we presented to participants differed in the directness of the causative relationship between agent and patient, with two involving relatively direct mechanical causation and two involving causation that might be perceived as more indirect.

Three conditions were run in a between-subjects design: Unaccusative, Transitive, and No Word (as described in Table 5.2). During the test phase of the experiment, participants were presented with two new events presented simultaneously on opposite sides of the screen. Both of the test events involved the person and objects presented during familiarization, but they differed in which of the subparts of the familiarized causative event were repeated (Table 7.1). One of the test events was a causative version of the New Means test events presented in Experiment 2, in which participants saw a causative event that differed from the familiarization event just in the means of causation (New Means test event). For example, after the familiarization event in which the boy makes the garden flower spin by pumping it with a bicycle pump, in the New Means test event, the boy makes the flower spin by hitting it with his hand. The other test event was one in which no causation occurred, but the MEANS and RESULT subevents presented during familiarization were both repeated (No Cause test event). In the No Cause test event involving the boy and the flower, the boy pumps the bicycle pump and the flower spins, but the pump is not connected to the flower: the boy's activity is not causally linked to the change of state in the flower. (A list of the test events that correspond to each familiarization event is available in Appendix 1, Table A5.) The auditory stimulus accompanying these test events directed participants to find the action represented by the novel verb introduced during familiarization.

Table 7.1

Test Events for Experiment 3

Phase	**Left side of screen**	**Right side of screen**	**Audio track**
Test	New Means boy makes flower spin by hitting it with his hand	No Cause boy pumps; flower spins (pump is not connected to flower)	Oh look! They're different. Do you see blicking? Do you see blicking? Where's blicking now?

Note that in both test events, the RESULT subevent was the same as that presented during familiarization, e.g., the ball is bouncing. Indeed, both test events repeat exactly two of the three subparts of the familiarized causative: the New Means test event is a causative event with the same result (CAUSE + RESULT), and the No Cause test event repeats both of the MEANS and RESULT subevents, but without a causal link between them (MEANS, RESULT). This particular pattern of repeated subparts has the effect of including causation as part of the possible extended meaning of the novel verb. Excluding exactly one subpart of the familiarized causative from each of the test events ensured that neither test event would be more familiar to participants than the other. The nature of the subparts excluded from each test event differed, however, allowing us to determine the relative linguistic significance of abstract conceptual elements like CAUSE versus the observable subevents MEANS and RESULT.

7.1.2 Results and Discussion

Both of the test videos presented in Experiment 3 depict an event with the same outcome as the causative presented during familiarization. They differ in whether there is a clear causal link between that outcome and the activity of the agent. In essence, then, the goal of the test phase in this experiment was to find out whether participants would be more willing to extend the novel verb presented during familiarization to refer to an event that shares its event type (i.e., causative) and RESULT subevent with the familiarization event but that differs in the semantic content of the MEANS subevent, or to an pair of noncausative events that repeat the observable MEANS and RESULT subevents of the familiarized causative. The relevant question to ask when examining these data, then, is which test event participants are willing to accept as an extension of the meaning of the novel verb presented during familiarization.

In this experiment, a language learner who will accept changes to the MEANS subevent of a complex causative should choose to extend novel verbs associated with that causative to include the test event in which the object's change of state is actually caused by the agent, regardless of what that agent is doing to effect the change. In the case of the causative event involving the boy and the flower, then, the verb *blick* should mean something like "cause to spin," and when asked to "Find blicking," these participants should choose the test event in which the flower's spinning has some visible external cause. Responses from participants in the No Word condition serve as an indicator of the relative salience of the two test events, due either to the perceptual appeal of a particular subevent or to some conceptual bias.

7.1.2.1 Children. The data reported here are from 33 participants (12 boys and 12 girls in each of the Unaccusative and Transitive conditions; 3 boys and 6 girls in the No Word condition) ranging in age from 22;7 to 26;1 months;days (mean age 23;30). An additional 13 children were run in the experiment, but were excluded from analysis for at least one of the following reasons: age (n = 3), language background (n = 1), inattention during the test phase for more than 35% on more than two trials (n = 1), experimenter error/equipment malfunction (n = 1), or study design (n = 7). Trials in which participants attended to the test events for less than 70% of the test period were excluded from analysis.

As in Experiments 1 and 2, we expected 2-year-olds to look longer at the test event that they were willing to label with the novel verb presented during familiarization when the test audio directed them to find that event. Table 7.2 provides data on the proportion of looks to the causative New Means test event in each condition, averaged across participants. Overall values represent looking during the entire 12 s test phase; Salience values represent looking during a 2 s salience period at the beginning of the test phase; and Word 1 values represent looking during a 2 s window around the offset of the first novel verb in the test audio ("Do you see blicking?"). During the salience period, participants have not yet heard the novel verb repeated, and their pattern of looking provides some information about baseline preferences for the two test events. Looking patterns around the novel verb, on the other hand, provide information about participants' preferences for extension of the novel verb presented during familiarization.

As can be seen from this chart, during the entire 12 s test period, participants in all three conditions spent just under half of their time looking at the New Means test event. (A chart detailing the average proportion of looks toward each test event during each frame of the 12 s test period is available in Appendix 2, Figure 3.) There were no significant differences between conditions in looking preferences during the Salience or Word 1 windows, nor were there significant differences across conditions in differences between looking during Word 1 and Salience (all $\sqrt{2}q^* = 3.48$, $p > .05$). Participant age, sex, and productive vocabulary were not significantly correlated with performance.

Table 7.2

Proportion of Looks to the Causative New Means Test Event, Experiment 3

Condition	***n***	**Overall**	**Salience**	**Word 1**
No Word	9	0.46	**0.43**	**0.55**
Unaccusative	12	0.46	**0.38**	**0.46**
Transitive	12	0.48	**0.40**	**0.57**

Proportions were calculated for each subject on the basis of the total time spent looking during the test phase, excluding time spent not looking at either test event. The data presented have been averaged across participants in each condition.

To determine which of the test events these 2-year-olds were willing to associate with the novel verb presented during familiarization, we compared looking times during the Salience and Word 1 windows in each condition. Assuming that the Salience window provides a measure of participants' baseline preferences for the two subevents, a significant shift in attention upon hearing the novel verb repeated in the test audio should serve as an indicator of the meaning that participants have associated with that verb. Figure 7.1 provides a graphical depiction of the mean proportion of visual fixation toward the New Means test event for each experimental condition during the 2 s Salience and Word 1 windows, averaged across participant and trial (error bars represent standard error).

There were no significant differences between the Salience and Word 1 windows in the No Word condition ($t(8) = 1.42$, $p = .19$). This is evidence participants did not find either of the two test events more salient on the basis of extralinguistic perceptual or conceptual cues.

When asked to find the test event that could be labeled by the novel verb presented during the familiarization phase, participants in the Unaccusative condition also demonstrated no significant preference for either test event that differed from their looking preference during the Salience window ($t(11) = .73$, $p = .48$). This result is not surprising, considering that the verb in an unaccusative intransitive frame unambiguously labels the result of a causative event. In this experiment, then, both of the test events included the subevent that participants in the Unaccusative condition would have identified as the meaning of the novel verb presented during familiarization, and their lack of preference for a single test event simply reflects this interpretation.

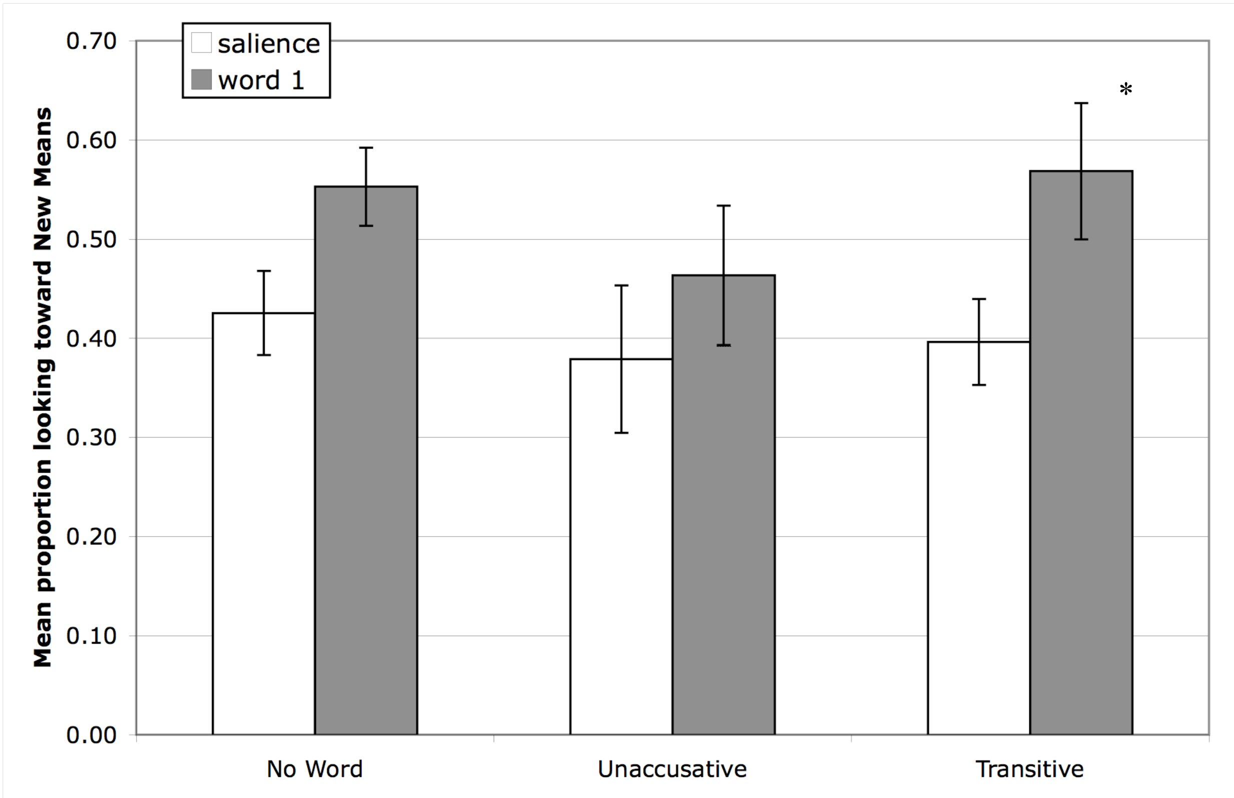

***Figure 7.1*. Mean visual fixation at test, Experiment 3**

* In the Transitive condition, mean looking during Word 1 is significantly different from looking during Salience.

Participants in the Transitive condition, on the other hand, showed a significant increase in their preference for the causative New Means test event (vs. salience) when asked to find the referent of the novel verb ($t(11) = 2.20$, $p = .05$). This trend is consistent across three trials: in the trials involving the flower, ball, and tower, looking at the New Means test event was at least 10% greater during Word 1 than during Salience; for the trial involving the light, looking at the two test events was roughly equal in the two windows. In the Transitive condition, 7 of 12 children looked at the New Means test event for at least 10% more of the Word 1 window than the Salience window (vs. 5 of 12 children in the Unaccusative and No Word conditions).

Recall that unlike the unaccusative frame, the transitive frame provides ambiguous information about the meaning of the verb it carries: the verb in a transitive frame can label either just the means of a causative event, as in (103b), or it can label a causative event, as in (103c).

(103) a. The boy is blicking the flower.

b. The boy is pumping the flower.

c. The boy is spinning the flower.

The preference for the causative New Means test event demonstrated in this condition, then, provides further evidence that children of this age are biased to interpret verbs in transitive frames as causatives (e.g., Lidz et al. 2003, Slobin 1985).[29] The fact that the proportion of

[29] Several audiences have wondered whether the preference that 2-year-olds in the Transitive condition of Experiment 3 exhibit for the New Means test event might be based on the contact between participants in this event, and not necessarily on their causal relationship. As reported in Chapter 2, contact between event participants is a crucial factor in the perception of direct causation (e.g., Leslie 1982, 1984b). I would argue, however, that contact is

looking toward the New Means test event does not appear to rise above chance in the Word 1 window is not troubling: as in the previous experiments, the crucial comparison is between baseline looking preferences and preferences exhibited when participants are asked to find the novel word, and not proportions of looking in each window vs. chance.

Note, moreover, that participants made this choice regardless of the fact that the means activity depicted in the test event was different from that presented in the familiarization event. This flexibility reveals that the semantic content that these participants assigned to their representation of the novel causative could not have included a highly specified MEANS subevent. This, then, is evidence that 2-year-olds are willing to accept changes to the MEANS subevent of a causative event labeled with a novel verb. Indeed, this kind of representation is what underlies the meanings of causative verbs like *spin* in (103c), which label both the change of state that an object undergoes and the idea that that change of state has been caused by some external agent without providing any information about what the agent did to bring about that change.

Interestingly, in this experiment we do not see the split observed in Experiment 2 between familiarization events involving direct and indirect causation, although the changes to the New Means test events are the same as those presented in that experiment. This suggests that children will allow more flexibility in the semantic identity of an agent-driven activity when it is perceived to the MEANS subevent driving a causative event than they will when the activity is perceived as an event in its own right.

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not enough on its own to account for the pattern of results reported in the four experiments reported here. Note, for example, that if contact were the only (or even the most important) event feature driving participant responses to transitive input, then 2-year-olds in the Transitive condition of Experiment 1 should have exhibited a preference for the Same Means test event over the Same Result test event, because that is the only one of the two test events in which the causative agent and patient make contact. This is not what we found.

Finally, it is important to note that neither group of 2-year-olds showed a preference for the No Cause test events, the event that repeated the MEANS and RESULT subevents of the familiarized causative but not their causal connection. This suggests that children of this age are sensitive to the fact that events that overlap in time and space are not necessarily related to each other. Recall from the baseball inning described in Chapter 2 the hot dog vendor who makes a sale just at the second that a ball is catapulted into a pop fly: although these two events both take place in the same instant and in the same general vicinity, we do not interpret them as causally connected. This pattern of results demonstrates, moreover, that 2–year-old children are aware that the (sub)events encoded in a single verb must be related in a partonomic hierarchy: even though the two events depicted in the No Cause test events were perceptually identical to the MEANS and RESULT of a familiar causative event, because participants did not perceive any linguistically relevant connection between them, they were unwilling to extend a single novel verb to label them.

7.1.2.2 Adults. We presented 27 adults with the same stimuli (9 in each experimental condition) presented to our 2–year-old participants, and asked them to decide in a forced-choice task which of the two test events could be labeled by the novel verb presented during familiarization.

Table 7.3 provides data on the proportion of adult participants who chose to extend the meaning of the novel verb to include the New Means test event rather than the No Cause test event in each experimental condition. Adults in the No Word condition demonstrated no preference for either test event ($t(8) = 1.18$, $p = .27$) and no effects of trial or stimulus event (both $F(1, 35) = .58$, $p = .45$). Participants also showed no overall preference for the New Means test event in the Transitive ($t(8) = –.89$, $p = .40$) and Unaccusative ($t(8) = –.51$, $p = .62$) conditions. However, in these conditions there is a significant correlation between test event choice and stimulus item (both $F(1, 34) = 29.85$, $p < .01$, $r^2 = .47$).

Further testing reveals a significant difference in test event choices by adults in the Unaccusative and Transitive conditions for novel verbs associated with familiarization events involving direct vs. indirect causation (both $t(8) = –4.62$, $p = .016$). Adults in both of these conditions (no difference between conditions, $t(16) = 0$, $p = 1$) chose the No Cause test event significantly more often for novel verbs associated with familiarization events involving indirect causation (i.e., the events involving the flower and light; $t(17) = –11.66$, $p < .01$). The New Means test event was chosen as an extension of the novel verb for familiarization events involving direct causation (i.e., the events involving the ball and tower) significantly more than chance ($t(17) = 2.20$, $p =.04$).

Table 7.3

Proportion of Adults Choosing the New Means Test Event, Experiment 3

		Trial				
		Direct		Indirect		
Condition	***n***	Ball	Tower	Light	Flower	Mean
Unaccusative	9	0.78	0.67	0.11*	0*	**0.39**
Transitive	9	0.67	0.78	0.11*	0*	**0.39**
No Word	9	0.67	0.56	0.44	0.56	**0.56**

* Mean proportion of test event choices is significantly different from chance (0.5).

In order to understand these results, let's take a moment to consider what we were asking the adult participants to do in this experiment. Consider first the Unaccusative condition: in Experiment 1, we saw that adults presented with novel verbs in unaccusative intransitive frames interpreted the novel verb as a label for the result of a causative event. In this experiment, however, the result subevent of the familiarized causative is repeated in both of the test events, and so both provided possible choices for extension of the novel verb. We also saw in Experiment 1 that adults presented with novel verbs in Transitive frames are not, like 2-year-olds, biased to interpret those verbs as causative. It is not unreasonable to assume that our adult learners in this experiment were aware of the range of meanings that a verb in a transitive frame can carry (97).[30] In this case, then, it was the input that was ambiguous.

By its very nature, the forced-choice task asks participants to select only one of the test events as an extension of the meaning of the novel verb. In both of these conditions, however, the input alone did not provide participants with enough information to distinguish between the two test events. Based on a comparison of responses by participants in the Unaccusative and Transitive conditions with those of participants in the No Word condition, it seems clear that labeling the familiarization event with a novel verb affected their choice of test event: indeed, participants in these conditions reported that they had chosen test events that were "more similar"[31] to the familiarization event.[32] My intuitions about the kinds of strategies these word learners might have used to make their choices, however, is limited to speculation on the basis of

[30] Contra Kako & Wagner (2001), it is not the frame itself that carries this meaning. Rather, our knowledge of the way that meanings map onto syntactic structures serves as a cue for word learning. These experiments demonstrate that this knowledge changes over time, as learners receive more data about how their language works (see also, e.g., Lidz et al. 2003).
[31] Quotations are taken from participant self-assessments.
[32] Participants in the No Word condition, on the other hand, reported that they had based their choices on features ranging from the movement of the object to the agent's facial expression or the overall strangeness of the test event.

prior research on the perception of causative events and participants' self-assessments of their own responses. The data that are available do not provide enough information to conclusively determine which features of the events were more salient to these word learners, and judging from the self-assessments provided, it is likely that even individual participants used a range of heuristics to make their choices.

Recall first that the difference between familiarization events involving direct vs. indirect causation is in the degree of closeness between the agent of the event and the patient entity in which he or she causes a change of state. The event involving the girl and the ball is an example of a familiarization event involving relatively direct causation: the girl waves a tennis racquet that makes direct contact with the bouncing ball. The event involving the boy and the flower is an example of a familiarization event involving relatively indirect causation: the boy stands to the side of the flower and is separated from the flower by a mechanical apparatus involving a bicycle pump.

The observed split between responses to verbs labeling causative events involving direct and indirect causation is not surprising, given the observation by Wolff (2003) that the degree of separation in time and space between a result and the activity that causes it affects a word learner's perception of the nature of the relationship between the (sub)events. Specifically, he reports that events of direct causation are usually perceived as a single event, and events of indirect causation are often perceived as more than one event. In this experiment, some of the participants in the Unaccusative and Transitive conditions did report that they perceived a difference between the events involving the ball and the tower (the more direct events) and those involving the light and the flower (the more indirect events). It is possible, then, that at least some of these participants based their responses on a comparison of the number of events they perceived in familiarization and test events. On this strategy, familiarization events involving direct causation would have been perceived as single events and matched with their corresponding causative New Means test events, which also depicted single events of direct causation, and familiarization events involving indirect causation would have been perceived as two events and matched with the No Cause test event, which also depicted two separate events.

Another possibility is that these different kinds of causation highlighted different subparts of the familiarization events, leading participants to choose the test event that repeated the CAUSE and RESULT subparts for familiarization events involving direct causation and the one that repeated the MEANS and RESULT subparts for those involving indirect causation. In fact, several participants showing this split in responses reported that they made their choices on the basis of either the contact between the agent/instrument and the object (for events of direct causation) or on what the agent was doing "even though it didn't cause the same result" (for events of indirect causation). Finally, at least some participants seem to have based their choice of test event on the perception of a causal relationship between the agent's activity and the change of state in the object: several even reported that they had postulated a hidden causal chain for the No Cause test events (e.g., a string attaching the racquet and the ball or a hidden cord attaching the crank and the light apparatus).

Given the wide range of response strategies available to adult word learners in this experiment, the observed pattern of responses provides little conclusive information about the changes that they are willing to accept in causative events labeled with single verbs. Note however, that there are many verbs in English that label the result of an externally caused event without specifying the means by which it was brought about. Indeed, we can use a verb like *bounce* in (104) to label an event with an unspecified means (104a) or with either of the means subevents presented in this experiment (104b,c).

(104) a. The girl is bouncing the ball, but I don't know how she is making it bounce.

b. The girl is bouncing the ball with the tennis racquet.

c. The girl is bouncing the ball with her hand.

Given this pattern of lexicalization, it seems clear that adults, like 2-year-olds, will allow some flexibility in the MEANS subevent that they associate with a causative event labeled by a single verb.

7.2 Experiment 4: Changing the RESULT

In Experiment 3, we observed that 2-year-olds would group two of the subparts of the causative together—i.e., CAUSE and RESULT—when extending the meaning of a novel transitive verb and allow for flexibility in the identity of the MEANS subevent. What we didn't know was whether this was the only possibility for grouping the subparts, or whether, if they were given the opportunity, children of this age would also be willing to group the MEANS and CAUSE subparts together without identifying a specific RESULT. If so, then this might suggest that what they've learned about these verbs is that they label causative events of some type, with no commitment to the identity of the means or the result subevents.

Experiment 4 was undertaken to shed some light on this mystery by exploring children's flexibility in encoding the semantic content of the RESULT subpart of a causative. As in Experiment 3, participants were first familiarized to a causative event labeled with a novel verb, and then at test, they were asked to extend the novel verb to one of two new events in which subparts of the familiarized causative (either the RESULT subevent or the causal connection between subevents) has been modified.

7.2.1 Design

The familiarization phase of Experiment 4 was identical to that described for Experiments 1–3, with participants familiarized to the same causative events labeled by novel verbs. Three input conditions were presented in a between-subjects design: Unergative, Transitive, and No Word (Table 5.2). During the test phase, participants were presented with two new events presented simultaneously on opposite sides of the screen. As in Experiment 3, both of the test events involved the person and objects presented during familiarization, but they differed in which of the subparts of the familiarized causative event were repeated (Table 7.5). One of the test events was a causative event that differed from the familiarization event in the change of state undergone by the patient (New Result test event). For the trial involving the boy and the flower, for example, in the New Result test event the boy continues to pump the bicycle pump attached to the garden flower, but now the flower moves up and down instead of spinning. The other test events were the same No Cause events presented in the test phase of Experiment 3, in which the MEANS and RESULT subevents presented during familiarization are repeated but are no longer causally related. In the No Cause test event involving the boy and the flower, the boy pumps a bicycle pump and the flower spins, but the pump is not attached to the flower: the pumping and the spinning are not causally linked. (A list of the test events that correspond to each familiarization event is available in Appendix 1, Table A6.) The auditory stimulus accompanying these test events directed participants to find the action represented by the novel verb introduced during familiarization.

Note that in both test events, the MEANS subevent was the same as that presented during familiarization, e.g., the boy is pumping. Indeed, as in Experiment 4, both test events repeat exactly two of the three subparts of the familiarized causative: the New Result test event is a causative event with the same causing activity (MEANS + CAUSE), and the No Cause test event repeats both of the MEANS and RESULT subevents, but without a causal link between them (MEANS, RESULT). This particular pattern of repeated subparts has the effect of including causation as part of the possible extended meaning of the novel verb. As in Experiment 3, excluding exactly one subpart of the familiarized causative from each of the test events ensured that neither test event would be more familiar to participants than the other. And again, the nature of the subparts excluded from each test event differs, allowing us to determine the relative linguistic significance of abstract conceptual elements like CAUSE versus the observable subevents MEANS and RESULT. Crucially, this experiment investigates whether participants will permit the same flexibility in the semantic identity of the RESULT subevent of a causative event labeled with a novel verb that we observed in Experiment 3 for the semantic identity of the MEANS subevent.

Table 7.5

Test Events for Experiment 4

Phase	**Left side of screen**	**Right side of screen**	**Audio track**
Test	New Result boy makes flower move up and down by pumping	No Cause boy pumps; flower spins (pump is not connected to flower)	Oh look! They're different. Do you see blicking? Do you see blicking? Where's blicking now?

7.2.2 Results and Discussion

Both of the test videos presented in Experiment 4 depict an event in which the agent is engaged in the same activity as in the causative presented during familiarization. They differ in whether there is a clear causal link between that activity and a change of state in the patient. The goal of the test phase in this experiment was complementary to that of Experiment 3: i.e., to find out whether participants would be more willing to extend the novel verb presenting during familiarization to refer to an event that is of the same event type as the familiarization event but that differs in the semantic content of the RESULT subevent (now the flower does something else when the boy pumps it) or to an event that is of a different event type than the familiarization event (i.e., not causative) but that matches the familiarization event in both of the observable MEANS and RESULT subevents. Again, the relevant question to ask when examining these data is which test event participants are willing to accept as an extension of the meaning of the novel verb presented during familiarization.

In this experiment, a language learner who is willing to accept changes to the RESULT subevent of a complex causative should choose to extend novel verbs associated with that causative to include the test event in which the agent's activity is the cause of the object's change of state. In the case of the causative event involving the boy and the flower, then, the verb *blick* should mean something like "cause by pumping," and when asked to "Find blicking," these participants should choose the test event in which the agent's activity clearly causes some change of state in the ball. Again, responses from participants in the No Word condition serve as an indicator of the relative salience of the two test events, due either to the perceptual appeal of a particular subevent or to some conceptual bias.

7.2.2.1 Children. The data reported here are from 34 participants (12 boys and 12 girls in each of the Unergative and Transitive conditions; 4 boys and 6 girls in the No Word condition) ranging in age from 22;8 to 25;25 months;days (mean age 23;29). An additional 19 children were run in the experiment, but were excluded from the analysis for at least one of the following reasons: unwillingness to complete the experiment (n = 1), inattention during the test phase for more than 30% on two or more trials (n = 4), interference from accompanying parent (n = 4), experimenter error/equipment malfunction (n = 4), or study design (n = 6). Trials in which participants attended to the test events for less than 70% of the test period were excluded from analysis. In addition, preliminary analysis of the data suggested that the New Result test event for the causative event involving the girl and the ball (in which the girl uses the tennis racquet to make the ball deflate) was markedly more interesting than the corresponding No Cause test event, and so it was excluded from the final analysis for all participants.

As in the previous experiments, we expected 2-year-olds to look longer at the test event that they were willing to label with the novel verb presented during familiarization when the test audio directed them to find that event. Table 7.6 provides data on the proportion of looks to the causative New Result test event in each condition, averaged across participants. Overall values represent looking during the entire 12 s test phase; Salience values represent looking during a 2 s salience period at the beginning of the test phase; and Word 1 values represent looking during a 2 s window around the offset of the first novel verb in the test audio ("Do you see blicking?").

Table 7.6

Proportion of Looks to the Causative New Result Test Event, Experiment 4

Condition	***n***	**Overall**	**Salience**	**Word 1**
No Word	9	0.54	**0.47**	**0.59**
Unergative	12	0.56	**0.48**	**0.69**
Transitive	12	0.52	**0.46**	**0.62**

Proportions were calculated for each subject on the basis of the total time spent looking during the test phase, excluding time spent not looking at either test event. The data presented have been averaged across participants in each condition.

As can be seen from this chart, during the entire 12 s test period, participants in all three conditions spent just over half of their time looking at the New Result test event. (A chart detailing the average proportion of looks toward each test event during each frame of the 12 s test period is available in Appendix 2, Figure 4.) There were no significant differences between conditions in looking preferences during the Salience or Word 1 windows, nor were there significant differences across conditions in differences between looking during Word 1 and Salience (all $\sqrt{2}q^* = 3.48$, $p > .05$). Participant age, sex, and productive vocabulary were not significantly correlated with performance.

To determine which of the test events these 2-year-olds were willing to associate with the novel verb presented during familiarization, we compared looking times during the Salience and Word 1 windows in each condition. Assuming that the Salience window provides a measure of participants' baseline preferences for the two subevents, a significant shift in attention upon hearing the novel verb repeated in the test audio should serve as an indicator of the meaning that participants have associated with that verb. Figure 7.2 provides a graphical depiction of the mean proportion of visual fixation toward the New Result test event for each experimental condition during the 2 s Salience and Word 1 windows, averaged across participant and trial (error bars represent standard error).

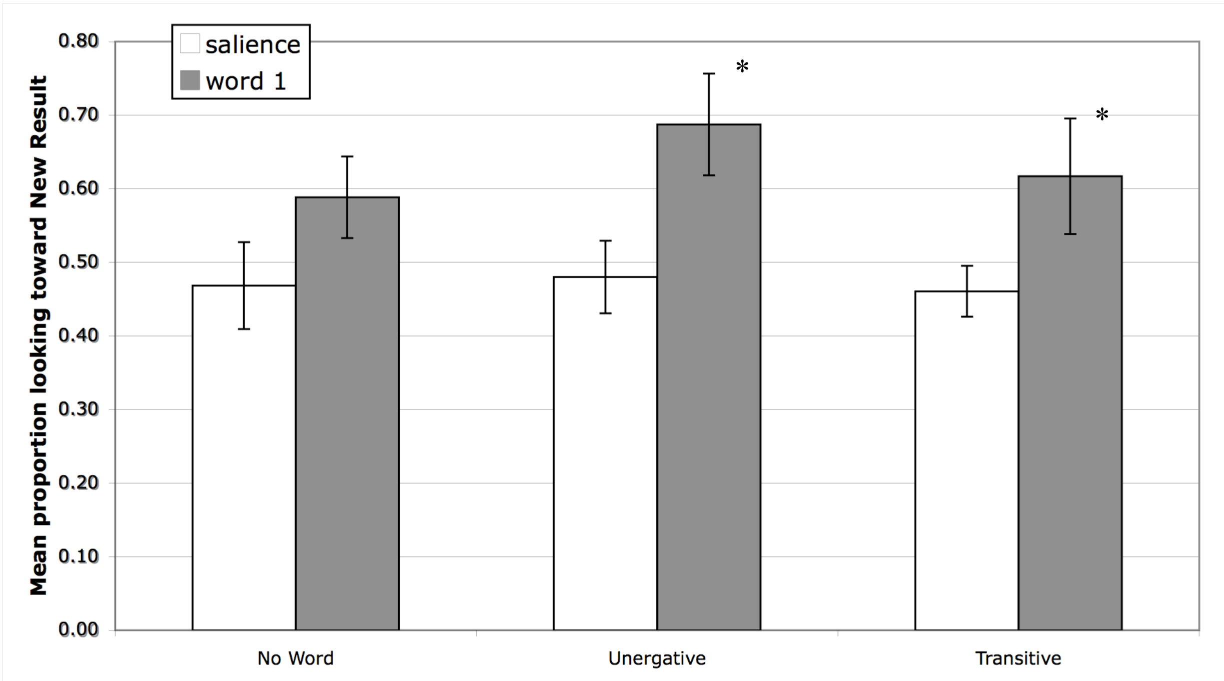

***Figure 7.2*. Mean visual fixation at test, Experiment 4**

* In the Unergative and Transitive conditions, mean looking during Word 1 is significantly different from looking during Salience.

In all three conditions, our 2-year-old participants exhibited a numerical preference for the New Result test event during the period of the test phase that we are calling Word 1 ($\sqrt{2}q^* = 3.48$, $p > .05$ for differences between conditions). When compared to baseline preferences exhibited in the Salience window, this preference was only significant in the Unergative and Transitive conditions (No Word: $t(9) = 1.31$, $p = .22$; Unergative: $t(11) = 2.19$, $p = .05$; Transitive $t(11) = 2.24$, $p = .05$). Across conditions, this trend is consistent in two of the three trials: in the trials involving the light and tower, looking at the New Result test event was at least 10% greater during Word 1 than during Salience. For the trial involving the flower, looking at the New Result test event was 8% greater during Word 1 in the Unergative condition, and in the No Word and Transitive conditions, looking at the No Cause test event was greater. In the No Word condition, 6 of 9 participants looked at the New Result test event for at least 10% more of the Word 1 window than the Salience window, 7 of 12 in the Transitive condition, and 8 of 12 in the Unergative condition.

It is not clear why we see this trend in the No Word condition, because this window of the test phase does not match up with any particular cues in the test audio as it does in the Unergative and Transitive conditions. It is possible, however, that there is some perceptual feature that makes the New Result test events more interesting than the No Cause test events during this time period.

In the Unergative and Transitive conditions, on the other hand, the Word 1 window corresponds to the point in the test phase in which participants were asked to find the test event that could be labeled by the novel verb presented during the familiarization phase. Because looking patterns in these conditions do not differ from looking patterns in the No Word control condition, we might conclude that participants in these conditions did not assign any meaning to the novel verbs presented during familiarization and that their looking patterns at test are driven by the same nonlinguistic biases that guided looking by participants in the No Word condition. However, because the preference exhibited in all three of these conditions for the causative New Result test event is exactly what we would expect if participants were willing to allow for flexibility in the semantic identity of the RESULT subevent of a complex causative labeled by a novel verb, we cannot definitely conclude that looking by participants in the Unergative and Transitive conditions was not guided by this interpretation. Since these data do not allow us to draw any firm conclusions about how (or whether) 2-year-olds in this experiment interpreted novel verbs, I will use the rest of this section to map out several possible explanations for the observed looking patterns and suggest some future studies that might help us to decide among them.

Recall, first, that what we attempted to do in this study was to teach 2-year-olds a single verb label for a causative event and then asked them to extend the meaning of that verb to include an event that differed from the familiarization event in one of the causative subparts. At test, they had the option of extending the novel verb to refer to a causative event that differed from the familiarization event in the change of state undergone by the patient entity (New Result) or to a pair of unrelated events that were identical to the MEANS and RESULT subevents of the familiarized causative (No Cause). As in Experiment 3, neither group of 2-year-olds showed a preference for the No Cause test events. This provides further support to the claim that children of this age are unwilling to extend a novel single verb label to refer to two events that are not related in a conceptual event hierarchy, even if they are identical to the MEANS and RESULT subevents of some causative event. Instead, participants in both the Unergative and Transitive conditions demonstrated a preference for the New Result test event.

One possible interpretation of this preference is that participants were indeed willing to extend the meaning of the novel verb to include the causative New Result test event. As described in Chapter 4, the interpretation of novel verbs presented in transitive frames as causative, at least, is fully consistent with the results reported in Experiments 1–3, as well as with observations found in the verb acquisition literature. Note, however, that the causative event that participants would be choosing in this case differs from the familiarization event in the identity of the RESULT subevent. This pattern of results would suggest, then, that 2-year-olds can encode a causative verb with a specific MEANS subevent but an unspecified RESULT subevent. This verb meaning, viz., MEANS + CAUSE, is never found in the wild: crosslinguistically there are no causative verbs that encode a specific means but not a specific result. In Chapter 3, I argued that this lexical gap reflects the fact that the meaning in question corresponds to an impossible linguistic representation: because the semantic primitive CAUSE (represented in the phrase structure as a light verb) always selects for an XP that specifies some change of state in a patient, specified MEANS and CAUSE subparts of a given causative event can never form a constituent to the exclusion of the RESULT, and so can never be encoded in a single verb. An interpretation of the looking patterns observed in this experiment as a willingness to accept a verb that encodes just the MEANS and CAUSE subparts of the causative is implausible, then: if a learner's hypotheses about the meanings of novel verbs are guided by linguistic constraints on possible structures, then this is a meaning that she should never hypothesize at all. Acceptance of verbs with this meaning poses a problem for learnability, moreover, because the crosslinguistic gap in verbs encoding this meaning entails that learners aren't going to get any negative evidence that verbs can't mean this.

Note, however, that even if we accept that 2-year-olds in this experiment are exhibiting a real preference for the New Result test events, this does not entail that their linguistic representations of these novel causative verbs don't include a result XP, just that that the semantic content of that XP has not been specified. Indeed, the fact that the 2-year-olds who participated in Experiments 3 and 4 were willing to accept changes to either the MEANS or the RESULT of a causative event labeled by a novel verb suggests that what they have learned about these novel verbs is that they encode causative events of some type, with no commitment to either the MEANS or the RESULT subevents.

In Chapter 2, I summarized experimental evidence demonstrating that events, like objects, are related in taxonomic hierarchies that reflect varying levels of abstraction in representation and categorization. In light of this kind of organizational structure, another possible interpretation of the preference for the New Result test event observed in this experiment is that 2-year-olds associated the novel verb label not with the basic-level events like spinning and bouncing depicted in these videos, but rather with a higher-level taxonomic category, perhaps something like causation (of an unspecified nature). This jump to a higher taxonomic level might be driven by something like the mutual exclusivity constraint that guides the acquisition of object labels (Markman 1993; see also Woodward 2000).

According to the mutual exclusivity constraint, children expect each entity in the world to be associated with a single label that denotes a basic-level object category. The constraint facilitates word learning by encouraging the acquisition of labels for object properties and for superordinate and subordinate event categories: when the learner is confronted with a situation in which the one-to-one mapping between entities and labels is violated, as in the case of a single entity is associated with more than one label or the case of two entities associated with a single label, they may interpret the labels as names for object properties or for object categories that are either more specific or less specific than the basic level. Several researchers have suggested, moreover, that mutual exclusivity plays a role in the acquisition of verbs and spatial terms (e.g., Merriman et al. 1996, Regier 1997, Woodward 2000).

In this experiment, if participants interpreted novel verbs in transitive and unergative intransitive frames as labels for the causative event presented during familiarization, it is possible that neither of the test events provided an option that could be construed as the same as the familiarized causative: the No Cause test events depicted two events that were not causally related, and the New Result test events depicted a causative test event that differed from the familiarization event in ways that forced learners to associated it with a different basic-level event category. On this analysis, then, during the test phase, we were effectively asking participants to interpret a single verb as a label for two different events. If something like mutual exclusivity was guiding their hypotheses about verb meaning, they would be led to interpret the novel verbs as labels for events that were either more specific or less specific than the basic level. In this case, the mapping of novel verbs to more specific events was discouraged by changes in the event features presented at test, and so participants interpreted novel verbs as labels for a superordinate event category. Their choice of the New Result test event rather than the No Cause test event suggests that the events that are included in this superordinate category share the conceptual feature of causation.

Finally, given the fact that the looking patterns observed in the Unergative and Transitive conditions were not different from those in the No Word control condition, it is also possible that when these 2-year-olds were confronted with two test events that did not provide a suitable match for the meaning they had associated with the novel verb during familiarization, they chose to ignore the event labels and behaved, like participants in the control condition, as if they had not been familiarized to anything in particular about the events. In this case, the preference for the New Result test event observed in all three conditions would be driven by nothing more than extralinguistic perceptual or conceptual biases.

Further investigation will be required before we can decide between these three possibilities. As a first step, we could run a habituation study to determine the relative acceptability of changes to causative subparts both in the absence of a novel verb label and in the presence of a novel verb in a transitive frame. (Previous results suggest that participants will associate novel verbs in transitive frames with the entire causative habituation event.) Participants would be habituated to our causative familiarization events and then presented at test with either the No Cause test event that corresponded to that familiarization event, the corresponding New Result test event from Experiment 4, or the corresponding New Means test event from Experiment 3.

The results of Experiments 3 and 4 suggest that, at least when the causative habituation event is labeled with a novel verb, dishabituation to the No Cause test event will be strong, given that 2-year-olds in Experiments 3 and 4 never accepted this event as an extension of the meaning of a novel transitive verb. On the other hand, the results of Experiment 3 suggest that participants will be willing to accept changes to the MEANS subevent of the causative when it is labeled by a novel verb, and so dishabituation to the New Means test event in the Transitive condition should be least pronounced.

If dishabituation to the New Result test event in the Transitive condition patterns like dishabituation to the No Cause test event, this will suggest that participants are unwilling to accept changes to the RESULT subevent of a causative event labeled with a single verb, allowing us to rule out the first two possibilities described above, i.e., that participants are either accepting a causative verb in which the RESULT subevent is underspecified or that they interpret these novel verbs as labels for a superordinate taxonomic event category. If, on the other hand, dishabituation to the New Result test event in the Transitive condition patterns like dishabituation to the New Means test event, this will suggest that participants are willing to accept changes to the RESULT subevent of a complex causative labeled by a single verb.

Finally, if we also find that participants in the No Word condition dishabituate more to the New Result test event than participants in the Transitive condition, this will provided strong evidence arguing against the possibility that language played no role in the pattern of results observed in Experiment 4.

Note, however, that even if this habituation study confirms that language did guide the looking patterns in Experiment 4, we still don't know whether participants exhibited a preference for the New Result test event because they were willing to accept a verb meaning that corresponds to an impossible linguistic representation or because they interpreted the verb as a label for a higher-level taxonomic category. To investigate which of these hypotheses is correct, we could run a preferential looking study in which causative familiarization events are labeled with novel verbs in transitive frames and then, at test, participants are given the choice of extending the novel verb to refer to either the No Cause test events, which repeat the MEANS and RESULT of the familiarized causative (i.e., leaving out only the causal connection between them) or to causative test events in which both the means activity and the resulting change of state are different from the familiarization events (i.e., preserving only the causal connection between event participants). If we find that children still demonstrate a preference for the causative test events over the No Cause test events, regardless of the fact that both of the causative subevents have been changed, this will provide strong evidence in favor of the claim that what these verbs label is a causal relationship between event participants and not any specific subevent.

These proposed studies are sketchy at best, and I will leave their refinement and execution to future work.

7.2.2.2 Adults. We presented 18 adults with the same stimuli (6 in each experimental condition) presented to our 2-year-old participants, and asked them to decide in a forced-choice task which of the two test events could be labeled by the novel verb presented during familiarization.

Table 7.7 provides data on the proportion of adult participants who chose to extend the meaning of the novel verb to include the New Result test event rather than the No Cause test event in each experimental condition. Stepwise ANOVA testing with condition, trial type (ball, flower, light, tower), trial number (1–4), and participant response as parameters revealed significant effects of condition (No Word vs. Transitive and Unergative: $F(1, 68) = 4.38$, $p = .04$, $r^2 = .14$) and trial number (trials 2 and 3 vs. 1 and 4: $F(1, 68) = 7.09$, $p = .01$, $r^2 = .09$). In the Transitive and Unergative conditions, participants demonstrated a significant (or near-significant) preference for the No Cause test events (Transitive: $t(5) = -2.44$, $p = .06$;

Unergative: $t(5) = -6.71$, $p = .001$). In the No Word condition, the observed preference for the No Cause test events was not significant ($t(5) = -1.16$, $p = .29$). Trial number appears to be significantly correlated with performance because only for trials 2 and 3 (the flower and ball events or the tower and light events, respectively, depending on the order of stimulus presentation) was this preference for the No Cause test events significant (trial 1: $t(17) = -2.04$, $p = .06$; trials 2 and 3: $t(17) = -5.10$, $p < .01$; trial 4: $t(17) = -.46$, $p = .65$).

Table 7.7

Proportion of Adults Choosing the New Result Test Event, Experiment 4

		Trial				
Condition	***n***	Ball	Tower	Light	Flower	Mean
No Word	6	0.5	0.67	0.17	0.17	**0.38**
Unergative	6	0.17	0.17	0	0.17	**0.13***
Transitive	6	0.17	0.33	0.17	0.17	**0.21**

* Mean proportion of test event choices is significantly different from chance (0.5).

In Experiment 2, we saw that adults presented with novel verbs in transitive and unergative intransitive syntactic frames were willing to interpret those verbs as labels for the MEANS subevent of a complex causative. In this experiment, both of the test events included the means activity presented during familiarization, and so both provided possible choices for the extension of novel verbs. Again, participant self-reflections provide insight into how these adult word learners decided which of the two test events to choose. One participant, for example, reported that she had initially assumed that the novel verbs referred to "what the agent was doing," but then when the agent was doing the same thing in both of the test events, she chose the one in which the object was also doing the same thing that it had during familiarization. Most participants gave some variation of this answer, reporting that they had chosen the test event that included the "same cause and effect" presented during familiarization. The preference for the No Cause test events observed here may, then, be evidence that these word learners were basing their choices on the perceptual similarity of the No Cause test event to the familiarization events, i.e., choosing the test event that included the highest number of observable subparts of the causative presented during familiarization. It is also likely, however, that at least some of the adults believed that they were choosing a causative event, despite the fact that the agent's activity and the change of state in the object were not observably related: as in Experiment 3, several adults in this experiment reported that they had hypothesized hidden causal chains for the No Cause test events, e.g., invisible wires linking the agent and patient.

It is important to point out, moreover, that the dispreference for the New Result test event observed across conditions and stimulus events in this experiment strongly suggests that these adult word learners were unwilling to accept changes to the RESULT subevent of a causative event labeled with a single verb. This dispreference is fully consistent with the crosslinguistic gap for verbs encoding causation: i.e., there are no verbs like *hit-cause* in (105) that specify the MEANS subevent of a complex causative without also specifying the RESULT subevent.

(105) The girl is hit-causing the ball, but I don't know what's happening to the ball.

7.3 General Discussion

Our goal in the experiments described in this chapter was to explore the flexibility that 2-year-olds and adults will allow in causative verb representations. Specifically, we wanted to investigate how these two groups of word learners resolve conflicts between hypothesized verb meanings and new information from the extralinguistic context. In both experiments, we familiarized participants to novel verbs labeling causative events. Across the two experiments, we then gave participants the option of extending the novel verb to label a causative event that differed from the familiarization event only in the MEANS subevent (Same Result, Expt. 3), a causative event that differed from the familiarization event only in the RESULT subevent (Same Means, Expt. 4), or to two separate events that were perceptually identical to the MEANS and RESULT subevents of the causative (No Cause). The pattern of results reported here provide some insight into the nature of young children's early verb representations.

Note first that if 2-year-olds' verb representations were strictly tied to the events that they first associated with a given verb, then they should always have chosen the test event that was perceptually most similar to the familiarization event, i.e., the No Cause test event. On the contrary, however, across the two experiments our 2-year-old participants preferred to accept changes to causative subevents rather than to the nature of the event being labeled by a novel verb: they never chose to extend the meaning of novel verb to label the No Cause test events. Instead, they appear to have been limited in the way that they mapped verb meanings onto event representations such that single verbs could only encode events that were related in a conceptual hierarchy. This suggests that the representations that 2-year-olds associated with these verbs encoded abstract information about the relationships between event participants, and not specific information about the semantic identity of the subevents.

In addition, Experiment 3 reveals interesting facts about the kinds of flexibility that language learners allow when encoding the semantic content of causative representations. Consistent with the results of Experiments 1 and 2, 2-year-olds in Experiment 3 interpreted novel verbs in unaccusative intransitive frames as labels for just the RESULT subevent of a complex causative. In this experiment, both test events repeated the RESULT subevent presented during familiarization, and so both provided equally good extensions of the novel verb (indeed, participants demonstrated no significant preference for either test event). This experiment also reveals, however, that 2-year-olds who learn a novel verb label for a causative event in a transitive frame will willingly extend that verb to label another causative event that differs in its MEANS subevent. This result could only be possible if the representations that children associate with these novel transitive verbs do not include a highly specified MEANS subevent.

Unfortunately, the results of Experiment 4 do not permit us to draw any conclusions about the flexibility that this group of word learners permits in the identity of RESULT subevents. If it is the case, however, that 2-year-olds are also willing to accept changes in the RESULT subevent associated with a novel transitive verb (or to both of the MEANS and RESULT subevents at the same time), then we would be left with a puzzle concerning how they decide which parts of a given causative event are specified by a given transitive verb: i.e., whether the verb encodes a causative event with a specified RESULT subevent or a causative event with a specified MEANS subevent. Results from previous studies using this paradigm, as well as from reactions to test stimuli during the salience periods of the experiments reported here, strongly suggest that word learners come to the test phase with preferences that have been shaped by their interpretation of the novel verb presented during familiarization. If it is the case, however, that children of this age are willing to interpret novel verbs in transitive frames as labels for a causative event with just one subevent specified (either MEANS or RESULT), then we need to determine whether they map novel verbs onto test events in these experiments by maintaining several hypotheses about the meaning of the novel verb and then choosing the one that best matches the options presented at test or whether they associate these novel transitive verbs with underspecified representations, perhaps hypothesizing just that they label causative events of some type, with no commitment to the specific semantic content of either the MEANS or the RESULT subevents.

In order to tease these two possibilities apart, we could present 2–year-old word learners with a version of the experiments described here in which they have the option at test of extending a novel verb familiarized in a transitive frame to either the New Means test event from Experiment 3 or the New Result test event from Experiment 4. If their verb representations are underspecified for both subevents, then they should show no preference for either test event. If, on the other hand, they maintain multiple distinct hypotheses about the meaning of the novel verb, we would expect those hypotheses to be ranked in some way (on the basis of linguistic or conceptual constraints), and so we should see a preference for one test event over the other.

In Experiment 4, we found that adults were unwilling to encode MEANS and CAUSE in a novel verb to the exclusion of a specified RESULT. When presented with a causative event labeled by a novel verb in a transitive or unergative intransitive frame, they chose to extend the verb to label the No Cause test events: noncausative pairs of events that repeated the MEANS and RESULT subparts of familiarized causatives rather than a single causative event with the same MEANS as the familiarization event but a different RESULT.[33] This pattern of results strongly supports the claim that this group of word learners is subject to a linguistic constraint on the way that the subparts of events can be encoded as single verbs. Recall that the verb meaning at issue here corresponds to an impossible linguistic representation: structurally speaking, causative verbs always specify a result XP, and so their meanings must include reference to a specific RESULT subevent. In this experiment, our adult word learners did not hypothesize meanings for the novel verbs that violated this constraint.

Unlike 2-year-olds, adults do not appear to be biased to interpret verbs in transitive frames as causatives, suggesting that they are aware of the ambiguity of the transitive frame. Indeed, in Experiment 3 it seems that that the transitive frame provided no relevant cues for verb learning at all. When presented either with input that did not provide enough information about what the novel verb meant or with test events that both provided possible extensions of the novel verb, adult learners had to rely on other kinds of strategies for deducing the meaning of the verb

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[33] Note that if this acceptance of the No Cause test event was due purely to the greater experience that adult learners have with causative verbs (as would be predicted by something like Tomasello's (2000) Island Hypothesis), then we might expect to see a shift toward a preference for this test event in 2–year-old participants that is correlated with increased production scores. This is not the case, however.

culled from their previous experience with the language. It is important to point out that the fact that adults can encode CAUSE and RESULT in a single verb is not in question. Although our results do not add to the evidence supporting this claim, they in no way conflict with it. They provide interesting insights, moreover, into the strategies other than syntactic bootstrapping that adults may use to make sense of new words that they encounter.

Indeed, these findings suggest that adults and 2–year-old children face word-learning situations with different resources and that they bring different strategies to the task of learning new words, at least in an experimental context. Our results demonstrate, for example, that although both groups of learners make use of syntactic cues to narrow their hypotheses about the meanings of novel verbs, the linguistic biases that inform word learning in each group are not identical. Specifically, we found that both groups of learners assumed that verbs presented in unaccusative intransitive frames labeled the change undergone by the patient of a causative event and that verbs presented in unergative intransitive frames labeled the agent's activity, but that novel verbs presented in transitive frames were interpreted by the children as labels for causative events and by the adults as labels for the agent's activity. These two groups of participants also seem to have been subject to different sets of conceptual constraints, such that children were never willing to extend single verbs to label events that were not visibly related to each other, but adults were, in some cases postulating sophisticated hidden mechanisms that created a causal connection between them. Given the differences in experience with the target language and the world in these two groups of learners, these differences in extrapolation heuristics are not surprising. They are important to take into consideration, however, especially given the recent trend to use adult learners to model word acquisition in children (e.g., Gillette et al. 1999, Snedeker & Gleitman 2004). The lesson must be, then, that these kinds of studies can be informative, but they are limited in that we cannot assume that what adults learners do in a given situation is the same as what children would do.

Chapter 8

Conclusions

From infancy, we represent causal events as being composed of a set of subevents associated in a hierarchical structure that reflects their partonomic and taxonomic relationships to one another. These subevents specify, at least, the activity engaged in by some agent entity that serves as a means of causation and the resulting change of state that is brought about in some patient entity. When we provide a description of a causative event that captures the relevant activity in a single verb, we may choose to encode all of the subparts in that verb, or we may choose to encode only individual subparts or partial sets of the subparts. Our linguistic representations of events are intimately tied to our conceptual representations, and languages reflect this complex internal structure in the grammar of the causative construction, such that each of these possible ways of encoding the subparts of the causative is associated with a different syntactic structure. It is not the case, however, that it is possible to encode any combinations of the subparts of the causative in a single verb, and crosslinguistic constraints on possible verb meanings reflect constraints on the mapping between linguistic and conceptual event representations.

One of the tasks that a language learner must accomplish is to figure out how the words of her target language map onto conceptual representations. In order to accomplish this task, the learner must be able to generate a limited set of hypotheses about the meaning of a novel word and to make use of linguistic and extralinguistic information observed over a range of situations to eliminate incorrect hypotheses until she narrows her set of hypotheses down to the conventional meaning of the word.[34]

In the real world, of course, the word-learning environment is not as carefully circumscribed as the stimuli presented in these experiments. Outside of the lab, learners are routinely faced with simultaneous and overlapping activities, the relevant bits of which may not actually be in their visual field, and with multiple streams of speech, possibly degraded by ambient noise. And it is only in very rare cases (if ever) that they receive something like a contrast event that explicitly rules out certain hypothesized verb meanings. Despite these obstacles, young children are efficient word learners, and are able to make use of information from multiple sources of information about words and the world (e.g., multiple input frames, multiple extralinguistic contexts of use, and pragmatic cues) to narrow down the meaning of a word. In a sense, then, these experiments provide a highly artificial learning environment and are limited in that they only reveal something about a small segment of the tools that are available for word learning.

The studies reported here were designed to offer a clearer picture of the range of meanings that language learners are willing to encode in single verbs associated with causative events and how the hypotheses they postulate about the meanings of novel verbs are constrained by conceptual and linguistic factors. Our investigation was guided by several specific questions: First, we wanted to find out which combinations of the subparts of a complex causative 2–year-old children and adults would be willing to encode as the meaning of a single novel verb.

[34] Note that this not just a challenge encountered by children and second language learners: when new words come into a language, adult speakers must also be flexible enough to adjust their hypothesis space until they agree on a meaning. I recently came to appreciate the difficulties faced by adults in converging on novel word meanings when I participated in a discussion between four adults trying to agree on the meaning of "baby mama."

Second, we wanted to probe the degree of specificity these learners encoded in representations of verb meaning: i.e., how closely their verb meanings are tied to representations of the specific events with which they were first associated. Finally, we wanted to compare verb learning in these two populations of language learners to shed some light on the heuristics that word learners use to narrow their hypotheses about the meanings of novel verbs: to find out how learners resolve conflicts between hypothesized verb meanings and new information from the extralinguistic context and how the strategies learners use change as they gain more experience with the linguistic and extralinguistic input.

Consistent with previous studies demonstrating the effects of linguistic cues on the acquisition of novel words, our results show that both children and adults use information from the syntactic frame in which a novel verb appears to guide their hypotheses about its meaning. Indeed, we found that even when learners are presented with a novel verb that is associated with a single complex causative event, syntactic information serves to spotlight various subsets of the causative subparts, making them more likely candidates for the meaning of the novel verb. In our experiments, when learners were provided with novel verbs in syntactic frames that provided unambiguous information about the subevents of the causative being highlighted, they interpreted the verbs as labels for those subevents: e.g., both 2–year-old children and adults interpreted novel verbs presented in unaccusative intransitive frames as labels for just the RESULT subevents of complex causatives and novel verbs presented in unergative intransitive frames as labels for just the MEANS subevent.

In many cases, however, syntactic cues do not provide enough information to eliminate all of the candidate hypotheses for the meaning of a novel verb. In these situations, learners must make use of multiple sources of information to arrive at the final meaning. In our experiments, when the syntactic input did not provide clear information about the causative subparts labeled by a novel verb, as in the case of novel verbs presented in transitive frames, we found differences in the interpretations postulated by our two populations of language learners that signal differences in the heuristics these sets of learners used to narrow the hypothesis space for verb meanings. When presented with novel verbs in transitive frames, our 2-year-olds interpreted them as labels for causative events, and our adults interpreted them as labels for agent-driven activities (here, for the MEANS subevents of causatives).

Both of these are possible meanings for a verb in a transitive frame, as illustrated by the sentences in (106): *homer* in (106a) labels an event in which Ramirez hits a ball with his bat, causing it to fly so far into the outfield that none of the opposing players can catch it, and *hit* in (106b) labels just what Ramirez does to the ball.

(106)	a. Ramirez homered the ball.	MEANS + CAUSE + RESULT
	b. Ramirez hit the ball.	MEANS

The choices made by 2-year-olds in these studies reflect an initial bias for causative events in children of this age that has been reported previously in the literature and that likely extends beyond word learning situations (e.g., Bowerman 1989, Lidz et al. 2003, Slobin 1985).[35] The

[35] It is important to point out that languages differ in the way that they carve up the world such that a learner has to figure out not only how Language in general maps onto conceptual representations, but also how her particular target language divides features of the world into individual words. Bowerman and colleagues (Bowerman 1989, Choi & Bowerman 1992) have demonstrated that crosslinguistic differences in the semantic categorization of spatial relationships has implications for the acquisition of prepositions. It remains to be seen, then, whether the pattern of

choices made by adults, on the other hand, indicate a move away from this initial bias, informed by the greater experience that this population of learners has both with verbs in transitive frames and with intentional acts.

Our results also reveal that the meanings that 2–year-old word learners postulate for novel verbs are highly constrained by the mapping between conceptual and linguistic event representations. Recall that in Experiments 3 and 4, our 2–year-old participants never chose to extend the meanings of novel verbs to include the No Cause test events, in which the MEANS and RESULT subevents of the familiarized causative were repeated but were not causally related. This pattern of results suggests that this group of language learners is limited in the way that they can map verb meanings onto structural representations of events, such that single verbs can only encode (sub)events that are related in a conceptual hierarchy.

Adult participants in these experiments, on the other hand, did choose to extend novel verbs to label the No Cause test events rather than the alternative test events in which either the MEANS or the RESULT subevent of the familiarized causative had been changed. What we did in these two experiments, essentially, was to ask participants to extend a novel verb to refer to an event that conflicted with the familiarized causative in one of two ways: they had the choice of extending the verb to refer either to an event that matched the familiarization event in event structure (i.e., it was causative) but that differed in the identity of the subevents within this

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results reported here will generalize to languages that differ from English in the way that they encode causation. As mentioned in Chapter 4, Lidz et al. (2003) demonstrated that children learning Kannada relied on transitive sentence frames as a marker of a verb's causativity even though the language possesses a morphological marker that provides a more reliable cue. It would be interesting to test the strength of this bias in a language like Turkish, which unlike English, typically encodes causation periphrastically, reserving the main verb for encoding manner and path of motion (Furman et al. 2006). In this language, then, adults should interpret novel verbs in transitive frames as labels for either the means or the result subevent of a causative. If children learning Turkish also interpret novel verbs in transitive frames as labels for causative events, this would provide additional evidence in support of the inherent salience of this category of events.

structure, or to a pair of events that were perceptually similar to the familiarized event (i.e., they matched the subevents of the causative) but that had a different event structure. When faced with a conflict between hypothesized verb meanings and new extralinguistic information, the adult word learners chose to extend novel verbs to label the test event that was perceptually the most similar to the familiarized causative and used their knowledge of the world to postulate the existence of hidden relationships (e.g., causal) between the two events.

Two–year-old word learners also demonstrated a disinclination to revise their interpretation of the kind of event representation labeled by a given novel verb, but, unlike adult learners, they were willing to loosen their commitment to the semantic identity of the causative subevents to respect that interpretation. That is, although they still represented the meaning of novel verbs in transitive frames as causative, they were willing to be flexible in what they would permit as the MEANS (and perhaps also the RESULT) subevent. Thus, although our 2-year-olds were only willing to map to single verbs combinations of the subparts of a causative event that corresponded to possible structural representations, as long as that structural constraint was satisfied, they were willing to be flexible in the specificity of the semantic content they assigned to the causative subevents: in Experiment 3, they accepted a change in the MEANS subevent encoded by a causative verb, and in Experiment 4, they may also have accepted a change in the RESULT subevent.

In Experiment 3, this flexibility led 2-year-olds to accept a test event that repeated the CAUSE and RESULT subparts of the familiarized causative as an extension of the novel verb, a meaning illustrated by the verb *propel* in (107), which labels the change of state that Ramirez causes in the ball without specifying the means by which he brought that change about.

(107) Ramirez propelled the ball. CAUSE + RESULT

In Experiment 4, however, the combination of causative subparts repeated in the test event preferred by this group of word learners (MEANS + CAUSE) corresponds to a combination of specific subparts that is that is impossible to represent in the grammar, given the constraint that verb meanings must correspond to possible linguistic representations. What this suggests is that the 2-year-olds in these experiments interpreted novel verbs in transitive frames as causative events of an unspecified nature, without making any commitment either to the change of state encoded by the verb or the means by which that change was brought about. It seems, then, that when this group of word learners encounters a mismatch between hypothesized word meanings and new information from the extralinguistic context, instead of adjusting their interpretation of what's happening in the world (as adult word learners do), 2-year-olds may adjust their assumptions about the taxonomic level of description that the word encodes. Thus, our 2-year-olds may have interpreted verbs in transitive frames as labels not for basic-level causative events, but rather for a superordinate-level event category "causative," which left the MEANS and RESULT subevents of the causative underspecified.

Taken together, the sensitivity to structural cues to verb meaning and the flexibility in encoding the semantic identity of causative subevents exhibited by our 2–year-old word learners provide clear evidence that the representations available to children of this age are not comprised of fixed snapshots of the particular event that they first associated with a given word (e.g., *pim* would mean: girl makes ball bounce by hitting it with a racquet). If their interpretations of novel verbs in these studies had been tied to representations of specific semantic content, 2-year-olds should always have extended novel verbs to refer to the test events that were perceptually more similar to the familiarization events. On the contrary, their willingness to accept changes to the identity of either the causing subevent or the resulting change of state demonstrates that these learners were tied to the structural representations of these events rather than to their specific content. This pattern of results provides strong support, then, in favor of the argument that children's early representations are abstract in nature, with even early verbs mapping to hierarchical structures that specify semantic details that mirror conceptual features relevant for event classification (including abstract relationships like CAUSE) but that are not strictly tied to specific events. This kind of representation provides the learner with an extremely powerful tool for word learning, allowing them to refine their hypotheses about the meanings of words they're acquiring as they encounter new information about them from cross-situational observation of their linguistic and extralinguistic contexts of use.

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Appendix 1

Study Design

Table A1

Inventory of Additional Vocabulary

word	**proportion of participants with productive use (n = 113)**
turn on	0.54
bounce	0.47
spin	0.32
rock	0.31
tower	0.30
tap	0.14
racquet	0.07
pump (noun)	0.02
crank (noun)	0.01
crank (verb)	0
pump (verb)	0

Table A2
Schematic of Stimulus Design, Experiment 1, Unaccusative Condition

Phase	Time	Left side of screen	Right side of screen	Audio track
Recentering	5 s	baby		giggle
Familiarization	6 s	boy makes a flower spin by pumping a bicycle pump	black screen	Look! The flower is blicking. Do you see the flower blicking?
	6 s	black screen	boy makes a flower spin by pumping a bicycle pump	Wow! The flower is blicking. Do you see the flower blicking?
	6 s	boy makes a flower spin by pumping a bicycle pump	boy makes a flower spin by pumping a bicycle pump	Yay! The flower is blicking. Do you see the flower blicking?
Contrast	6 s	(centered) boy waves flower from side to side		Oh no! Now the flower is not pimming. The flower is not pimming.
Familiarization	6 s	boy makes a flower spin by pumping a bicycle pump	boy makes a flower spin by pumping a bicycle pump	Yay! Now the flower is blicking. Do you see the flower blicking?
Test	12 s	<u>Same Result</u> flower spins (boy does nothing)	<u>Same Means</u> boy pumps (flower does nothing)	Oh look, they're different. Do you see blicking? Do you see blicking? Where's blicking now?

Table A3

Test Events, Experiment 1

Novel verb	**Causative event**	**Same Result**	**Same Means**
Pim	girl hits ball with tennis racquet, ball bounces	ball bounces (girl does nothing)	girl hits ball with racquet (ball does nothing)
Lorp	boy hits ring tower with stick, tower rocks back and forth	tower rocks (boy does nothing)	boy hits tower with stick (tower does nothing)
Blick	boy pumps bike pump attached to garden flower, flower spins	flower spins (boy does nothing)	boy pumps (flower does nothing)
Grek	girl turns crank attached to light, light bulb turns on	light bulb turns on (girl does nothing)	girl turns crank (light bulb does nothing)

Table A4

Test Events, Experiment 2

Novel verb	**Causative event**	**Same Means**	**New Means**
Pim	girl hits ball with tennis racquet, ball bounces	girl hits ball with racquet (ball does nothing)	girl hits ball with her hand (ball does nothing)
Lorp	boy hits ring tower with stick, tower rocks back and forth	boy hits tower with stick (tower does nothing)	boy hits tower with his hand (tower does nothing)
Blick	boy pumps bike pump attached to garden flower, flower spins	boy pumps (flower does nothing)	boy hits flower with his hand (flower does nothing)
Grek	girl turns crank attached to light, light bulb turns on	girl turns crank (light bulb does nothing)	girl taps bulb with her hand (light bulb does nothing)

Table A5

Test Events, Experiment 3

Novel verb	**Causative event**	**New Means**	**No Cause**
Pim	girl hits ball with tennis racquet, ball bounces	girl makes ball bounce by hitting it with her hand	girl waves racquet; ball bounces (racquet and ball do not make contact)
Lorp	boy hits ring tower with stick, tower rocks back and forth	boy makes tower rock by hitting it with his hand	boy waves stick; tower rocks (stick and tower do not make contact)
Blick	boy pumps bike pump attached to garden flower, flower spins	boy makes flower spin by hitting it with his hand	boy pumps; flower spins (pump is not connected to flower)
Grek	girl turns crank attached to light, light bulb turns on	girl makes light bulb turn on by hitting it with her hand	girl turns crank; light bulb goes on (crank is not attached to light)

Table A6

Test Events, Experiment 4

Novel verb	Causative event	New Result	No Cause
Pim	girl hits ball with tennis racquet, ball bounces	girl makes ball deflate by hitting it with the racquet	girl waves racquet; ball bounces (racquet and ball do not make contact)
Lorp	boy hits ring tower with stick, tower rocks back and forth	boy uses stick to knock tower over	boy waves stick; tower rocks (stick and tower do not make contact)
Blick	boy pumps bike pump attached to garden flower, flower spins	boy makes flower move up and down by pumping	boy pumps; flower spins (pump is not connected to flower)
Grek	girl turns crank attached to light, light bulb turns on	girl makes light flash on and off by cranking	girl turns crank; light bulb goes on (crank is not attached to light)

Appendix 2

Timeline Data

Charts detailing the average proportion of looks to each test event, averaged across participants and trials, for each frame of the 12 s test phase are provided for each experiment on the pages that follow. Data from trials in which participants were not attending to either test event for more than 65% of the test phase are excluded from these timelines.

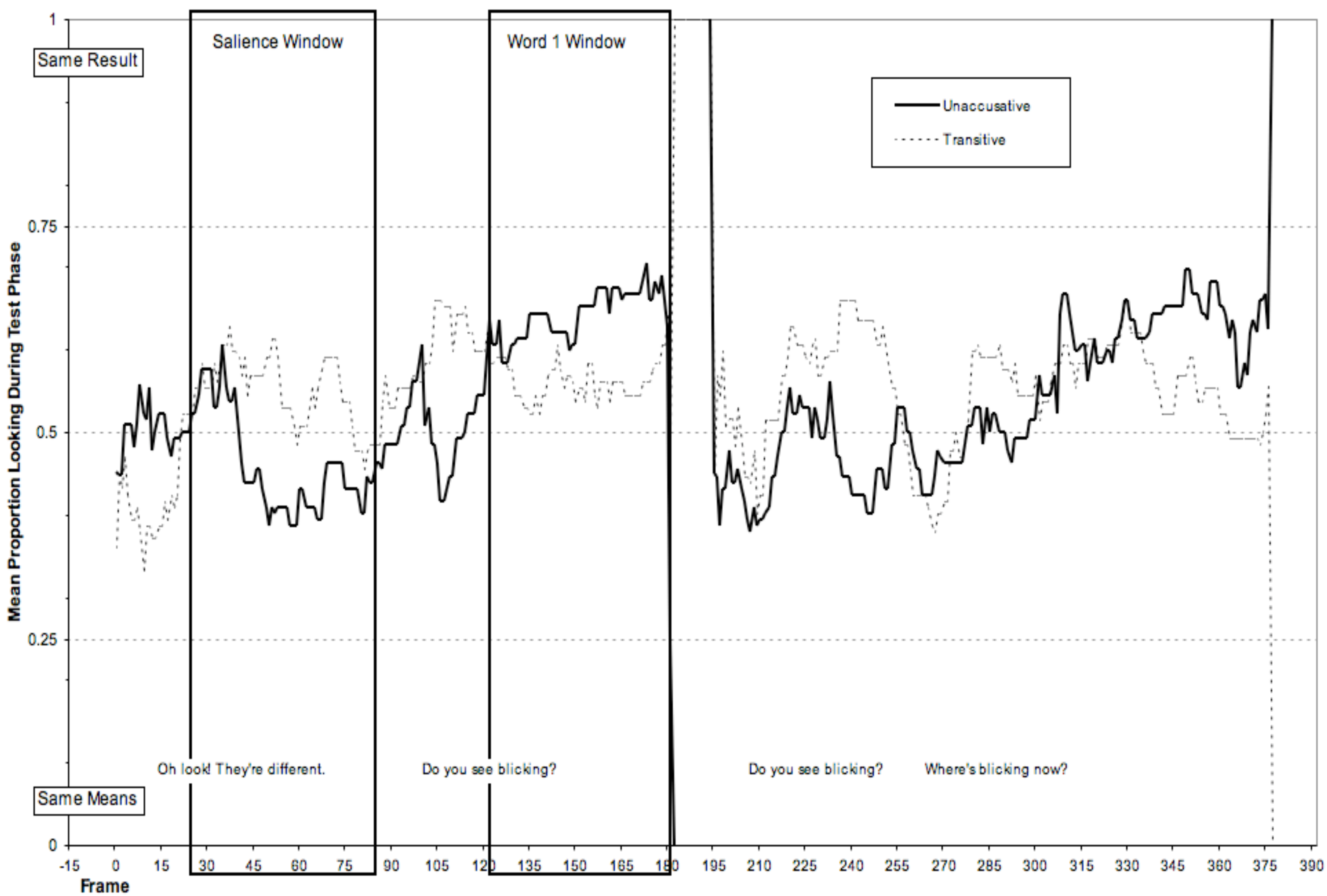

Figure A1. **Timeline of mean looking at Same Means and Same Result test events during test phase, Experiment 1**

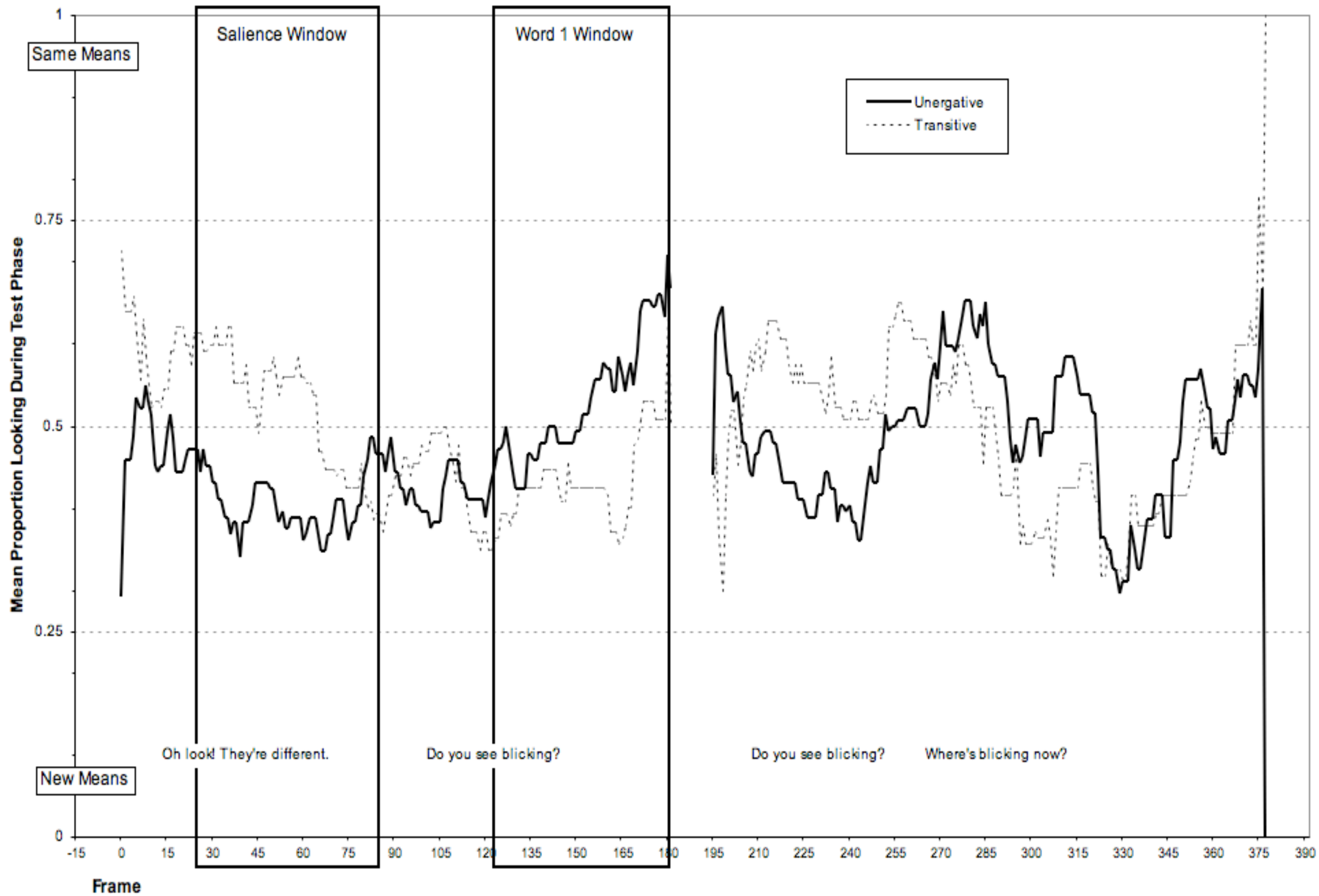

***Figure A2*. Timeline of mean looking at Same Means and New Means test events during test phase, Experiment 2**

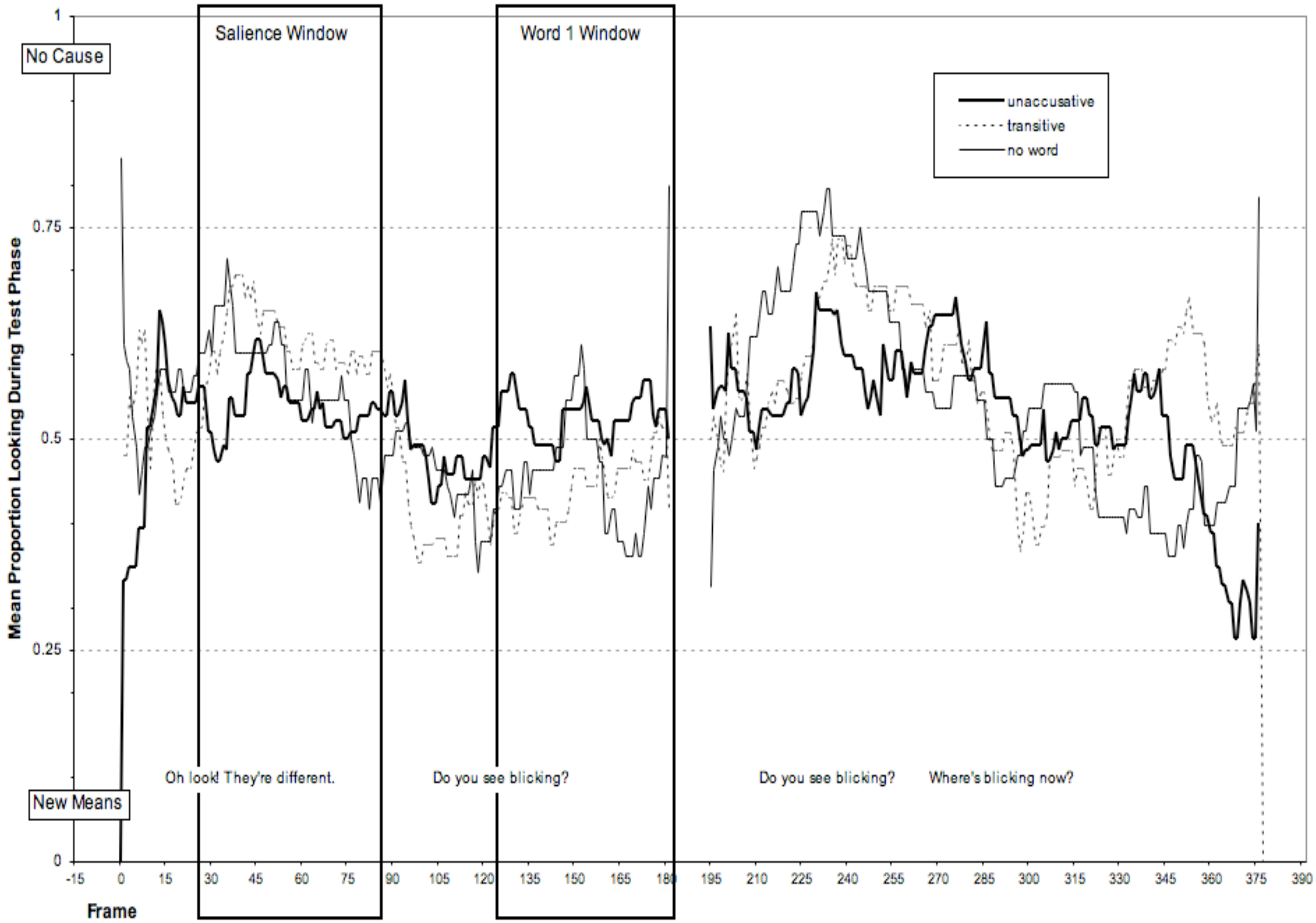

Figure A3. **Timeline of mean looking at New Means and No Cause test events during test phase, Experiment 3**

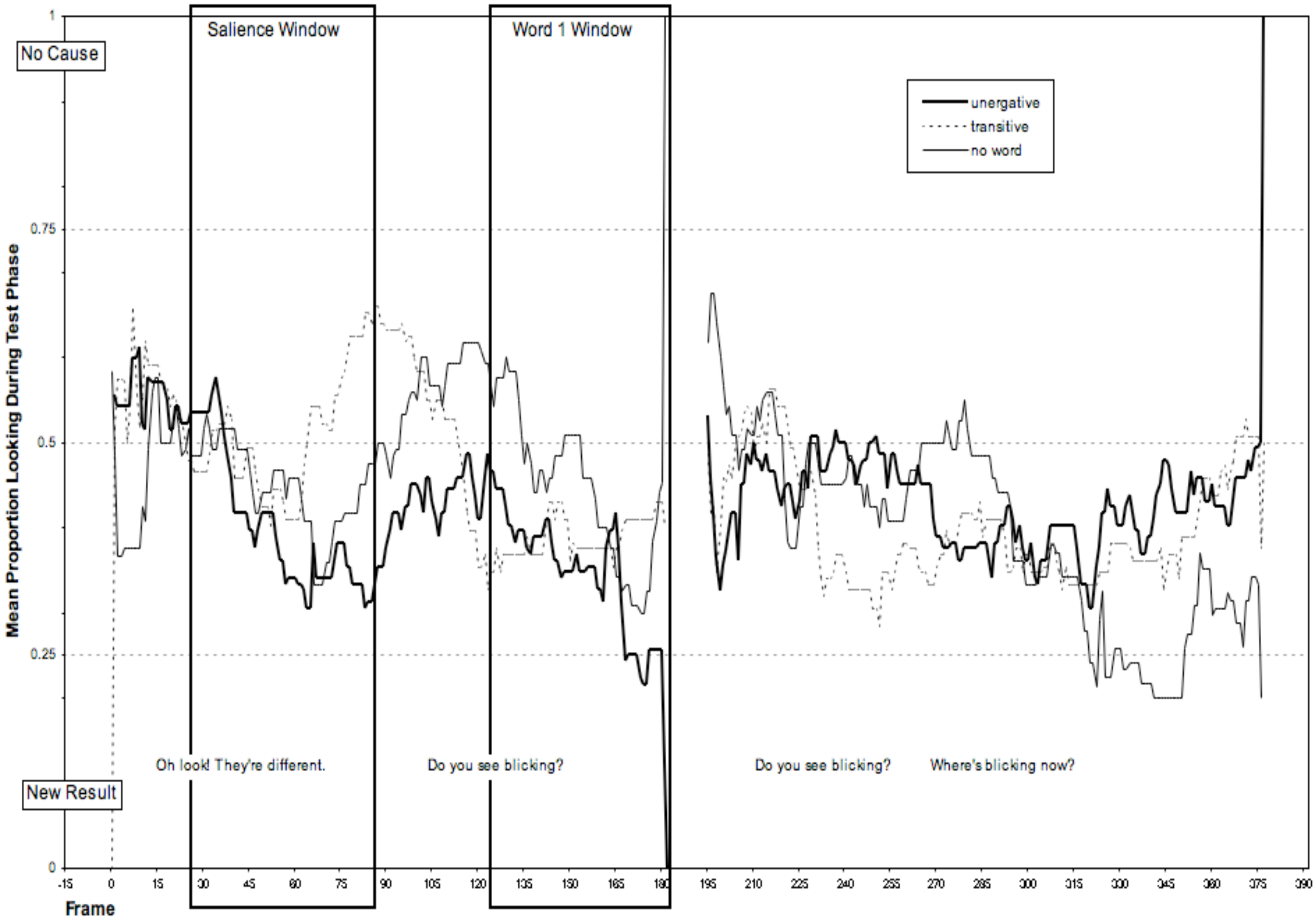

Figure A4. **Timeline of mean looking at New Result and No Cause test events during test phase, Experiment 4**

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Education

2006	Ph.D., Department of Linguistics, Northwestern University, Evanston, Illinois Specialization in Language and Cognition, Spring 2003 Specialization in Cognitive Science, Spring 2002
2003	Linguistic Society of America Summer Institute, Michigan State University, East Lansing, Michigan
1997	University of Denver Publishing Institute, Denver, Colorado
1997	B.S., The College of William and Mary, Williamsburg, Virginia Concentrations: Biology, Linguistics

Research Interests

Language acquisition and processing, syntax-semantics-cognition interface, event representation

Research Experience

2005–06	Research Assistant for Jeffrey Lidz, Northwestern University
2001–02	Research Assistant for Christopher Kennedy, Northwestern University
2001	Research Internship with Michael Walsh Dickey, Northwestern University

Grants and Fellowships

2004–05	Dissertation Year Fellowship, Northwestern University
2004	Research Fellow, Northwestern University
2003, 05	Paula Menyuk Travel Award, BUCLD
2003	Summer Institute Fellowship, Linguistic Society of America
2003	Graduate Research Grant, Northwestern University ($1500)
2000, 01, 02, 03	Summer Research Fellowship, Northwestern University
1999–2000	Cognitive Science Fellow, Northwestern University
1993–97	National Merit Scholar, James Monroe Scholar, Virginia Scholar; The College of William and Mary

Publications

In press	Bunger, A. & J. Lidz. "Constrained flexibility in the extension of novel causative verbs." *Proceedings of the 32nd Annual Meeting of the Berkeley Linguistics Society*. Berkeley, CA: BLS.
2006	Bunger, A. & J. Lidz. "Constrained flexibility in the acquisition of causative verbs." *Proceedings of the Annual Boston University Conference on Language Development*. Cascadilla Press: Cambridge.
2004	Bunger, A. & J. Lidz. "Syntactic bootstrapping and the internal structure of causative events." *Proceedings of the Annual Boston University Conference on Language Development*. Cascadilla Press: Cambridge.
2004	Lidz, J., E. McMahon, K. Syrett, J. Viau, F. Anggoro, J. Peterson-Hicks, E. Sneed, A. Bunger, T. Flevaris, A. Graham, K. Grohne, Y. Lee, & E. Strid. "Quantifier raising in 4-year-olds." *Proceedings of the Annual Boston University Conference on Language Development*. Cascadilla Press: Cambridge.

Invited Colloquium Presentations

2006	*How we learn to talk about events: Linguistic and cognitive constraints on verb learning*. Department of Linguistics, Fresno State University, Fresno, CA. April 6, 2006.
2005	*How we learn to talk about events: Verb acquisition and universal grammar*. Linguistics Program, The College of William and Mary. April 7, 2005.
2004	*Syntactic bootstrapping and the internal structure of causative events*. Laboratoire de Sciences Cognitives et Psycholinguistique, Department de Biologie, Ecole Normale Superieure, Paris, France. February 19, 2004.
2003	*Syntactic bootstrapping and causative events*. Linguistics Program, The College of William and Mary. April 3, 2003.

Unpublished Conference Presentations

2006	*When one cue is better than two: Syntactic vs. lexical information in infant verb learning.* (w/Jeffrey Lidz, Erin Leddon, Sandra Waxman). Workshop on On-Line Methods in Children's Language Processing, New York, NY, March 21–22, 2006.
2006	*Constraints on two-year-olds' extensions of novel causative verbs.* (w/Jeffrey Lidz). Annual Meeting of the Linguistic Society of America, Albuquerque, NM, January 5–8, 2006.

2004	*Two-year olds have complex representation for causatives*. (w/Jeffrey Lidz). Annual Meeting of the Linguistic Society of America, Boston, MA, January 8–10, 2004.
2003	*Lexical frequency effects elided: evidence from the processing of sluicing*. (w/Michael Walsh Dickey). 16th Annual CUNY Conference on Human Sentence Processing, Cambridge, MA, March 27–29, 2003.
2002	*Methods of assessing argument structure preferences: sentence completion versus argument structure estimation*. (w/Michael Walsh Dickey). 15th Annual CUNY Conference on Human Sentence Processing, New York, NY, March 21–23, 2002.
2002	*Spoken word recognition and grammatical category*. Annual Meeting of the Linguistic Society of America, San Francisco, CA, January 3–6, 2002.

Teaching Experience

Northwestern University

2004, 05	ESL Instructor, International Summer Institute Conversation and Presentation Skills Pronunciation
2004	Adjunct Lecturer Child Language
2003	ESL Instructor Written English for Non-Native Speakers
2002, 03, 04, 05	ESL Tutor
2002	Guest Lecturer Introduction to the Study of Words (Topic: Meaning Relations)
2000, 01, 03	Teaching Assistant Language and Prejudice Formal Introduction to Words and Sentences Language and the Brain

The College of William and Mary

1997	Teaching Assistant Study of Language

Professional Service and Activities

Northwestern University

2004–06	Teaching Consultant, Searle Center for Teaching Excellence, Northwestern University
2002, 03	Teaching Assistant Fellow, Searle Center for Teaching Excellence, Northwestern University
2002–03	Preparing Future Faculty Program, Northwestern University

Northwestern University Department of Linguistics

2004–06	Noon Colloquium Coordinator, Department of Linguistics, Northwestern University
2005–06	Syntax-Semantics Graduate Student Reading Group
2005–06	Chicago Syntax-Semantics Circle
2001–06	Linguistics-Psychology-Acquisition Lab Groups
2001–04	Librarian, Department of Linguistics, Northwestern University
2001	Student Liaison, Search Committee for Assistant Professor in Semantics, Northwestern University
1999–2001	Reception Committees, Department of Linguistics, Northwestern University

External Organizations

1999–present	Member, Linguistic Society of America

Languages

English: native speaker

German: limited conversational and reading skills

American Sign Language: limited conversational skills

Korean: research experience