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Thematic relations as a cue to verb class: 2-year-olds distinguish unaccusatives from unergatives

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Abstract

Previous work shows that children use syntactic information to guide their hypotheses about verb meaning. Bunker & Lidz 2004 demonstrated that 2-year-olds map novel unaccusative verbs onto just the result subevent of a complex causative event and novel transitive verbs onto the entire causative event. We present data from a new preferential looking study demonstrating that 2-year-olds map novel unergative verbs onto the means subevent of a causative. We conclude that the interpretation of novel verbs is driven not only by the number of arguments in a given syntactic frame, but also by the semantic roles played by those arguments.

Thematic Relations as a Cue to Verb Class: 2-Year-Olds Distinguish Unaccusatives from Unergatives

Ann Bunger and Jeffrey Lidz*

1 Introduction

When a learner attempts to map a new verb that she has encountered onto some real-world event, the hypotheses that she postulates for the meaning of that novel verb are guided by the integration of cues from the linguistic and extralinguistic context in which the verb was uttered. The sentences in which learners hear novel verbs modeled contain several kinds of cues about the kind of event being labeled by the verb: they provide information about the syntactic behavior of the verb, i.e., the number of arguments that it can occur with, and about the semantic content of those arguments, i.e., which participants in a given scene in the world are being included in the event labeled by the verb. It is the case, moreover, that things about the world other than just the number and identity of the entities moving around in it affect the way that we encode verb meanings. Details like whether the entities involved in a given event make contact with each other and whether and how closely they are related in a causal chain (Bunger 2006, Wolff 2003) affect how we can encode an event or set of events involving those entities in a verb. The goal of this study was to find out how very young word learners integrate these different kinds of cues to map verbs to events: whether the meanings that 2-year-old word learners postulate for novel verbs are guided only by the number of nouns associated with a given verb or whether learners of this age are also sensitive to the way that those arguments map onto specific entities playing particular roles in an event labeled by the verb.

It is well established that there are systematic mappings between the meanings of verbs and their syntactic behavior, such that verbs that refer to similar event types can occur in similar syntactic frames (Carter 1976, Gruber 1965, Jackendoff 1990, Levin 1993, etc.). An example of this fixed relationship can be seen in the so-called Causative/Inchoative alternation

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(Hall 1965, Levin 1993), illustrated in (1). The verb *bounce* can appear both in a transitive frame, as in (1a) and in an unaccusative intransitive frame, as in (1b), in which the object of the transitive sentence appears as the subject of the intransitive.

- (1) a. The girl is bouncing the ball.
 b. The ball is bouncing.

Verbs that can participate in this alternation must describe events that are internally complex: here, the girl performs some action, and that action causes a change of state in the ball.

Previous work on the conceptual (Pietroski 2000, Thomson 1977) and linguistic (Bunger and Lidz 2004, Levin and Rappaport Hovav 1995, Talmy 1985) representation of events has shown that both adults and young children represent causative events as being made up of multiple distinct subparts. In the case of this bouncing event, these subparts could be represented as in (2), which specifies a means subevent (what the girl does to the ball), a result subevent (what happens to the ball), and the causal relationship between these two subevents (our understanding that the girl's hitting of the ball is directly responsible for the ball's bouncing).

- (2) [[girl hits ball] CAUSE [ball bounces]]
 MEANS RESULT

Crucially, verbs that can occur in the Causative/Inchoative alternation must be labeling the result subpart of this complex event: it's the ball that bounces in (1a), not the girl. And as it turns out, *bounce* is just one of an entire class of verbs that can participate in this alternation—other members of the verb class include things like *spin* and *roll*, all of which label the result of some complex causative event (Levin 1993). Indeed, the verb *hit* cannot participate in this alternation (3) precisely because it does not label the result of a causative event. In (3a) it is the boy that *hits*, and not the ball.

- (3) a. The boy hit the ball.
 b. *The ball hit.

There is a rich body of experimental literature demonstrating that language learners can use these kinds of systematic regularities in the mapping between verb syntax and verb semantics to constrain their hypotheses about the meanings of novel verbs that they encounter (Fisher 2002, Fisher et al. 1994, Gleitman 1990, Landau and Gleitman 1985, Naigles

1990, etc.). It is not yet clear, however, exactly which bits of syntactic information young verb learners are sensitive to.

As a first attempt at uncovering the syntactic cues that are of value to young learners, Fisher (2002) investigated whether the meanings that 2.5-year-old children hypothesize for novel verbs associated with causative events are influenced by the number of noun arguments in an input frame. In this study, she familiarized children to short videos of causative events involving two female participants, e.g., to an event in which one girl wheeled another girl back and forth in a wagon. Accompanying these events, she presented her participants with novel verbs in syntactic frames that specified either one or two noun phrase arguments for the verb: some heard the event described in a transitive frame, which included two arguments (4a), and others in an intransitive frame, which included only one argument (4b):

- (4) a. She's pilking her.
b. She's pilking.

After repeating the videos several times, Fisher paused the videotape in the middle of the event and asked her participants to tell her which of the women in the event was doing the *pilking*. What she found was that children who had heard novel verbs in transitive sentences were more likely to identify the agent of the event (here, the girl doing the pulling) as the pilker, and those who heard novel verbs in intransitive sentences were more likely to identify the patient of the event (the girl being pulled in the wagon) as the one doing the pilking. Fisher concludes from these results that language learners of this age do use the number of arguments associated with a novel verb as a clue to its meaning.

It is important to keep in mind, however, that number of arguments alone provides ambiguous information about verb meaning; i.e., not every verb in an intransitive (one-argument) frame labels the result of a causative event. While it is true that the intransitive variants of causative verbs like *bounce*, *spin*, and *roll* label results (5a), there are also classes of intransitive verbs like *jump*, *run*, and *play* which label the (usually noncausative) activity of some agent (5b).

- (5) a. The ball is bouncing/spinning/rolling.
b. The girl is jumping/running/playing.

Note, crucially, that the kind of event being labeled by an intransitive verb is signaled by its single argument: unaccusative intransitives like *bounce* take the object undergoing some change of state in a causative event as their

subjects, whereas unergative intransitives like *jump* take an agent as their subjects. The question remains, then, whether all of the information that language learners use from an input frame is purely structural, like the number of arguments that the verb takes, or whether they can also make use of the semantic content of those arguments to map particular event participants onto structural representations.

Bunger and Lidz 2004 began to investigate this question. In this preferential looking study, we first familiarized 2-year-old children to videos of events in which a human agent caused some change of state in an inanimate object, e.g., to an event in which a girl made a ball bounce by hitting it repeatedly with her hand. Like Fisher's events, ours were accompanied by novel verbs presented either in transitive or intransitive frames. Unlike Fisher, however, we explicitly identified the arguments of the verbs for our word learners: our intransitive verbs were always unambiguously unaccusative, i.e., their single argument always labeled the undergoer in the event. Examples of our test sentences are given in (6):

- (6) a. The girl is pimming the ball.
b. The ball is pimming.

During the test phase of the study, we presented participants with two simultaneous videos, one that depicted just the means subevent of the familiarized causative and one that depicted just the result subevent. For the familiarization event involving the girl and the ball, then, one test event showed the girl hitting a ball that didn't bounce, and the other showed a ball that bounced with no help from the girl. While they watched these two test events, we asked our participants to choose the one that best matched their interpretation of the novel verb presented during familiarization. What we found was that children who had been presented with novel verbs in unaccusative intransitive frames preferred to extend the verb to include the test event in which the ball was bouncing on its own, demonstrating that they had interpreted the verb as a label for the change of state undergone by the ball.

In essence, this is the same result reported in Fisher 2002: Fisher's 2.5-year-old learners also associated novel verbs in intransitive frames with the change of state undergone by the causative patient. Our goal in the current study was to find out whether this is the only option for the interpretation of novel verbs in intransitive frames, or whether, under the right circumstances, young language learners would also be willing to associate a novel verb in an intransitive sentence with the activity of the agent of a causative event.

2 Methods

The participants consisted of 24 children (6 boys and 6 girls in each experimental condition) ranging in age from 22;8 (months;days) to 25;27 (mean 24;16). All were being raised in English-speaking homes.

This study makes use of the preferential looking paradigm developed by Spelke (1979) and Golinkoff et al. (1987) to study intermodal perception in infants. Our version of the task consists of three phases: familiarization, contrast, and test. During the familiarization phase, participants were presented with videos in which a human agent caused some observable, instrument-mediated change of state in an inanimate object. These causative familiarization events differed in how closely the causing activity and the change of state were associated: two of the events involved relatively direct mechanical causation, e.g., a girl makes a ball bounce by hitting it repeatedly with a tennis racquet, and the other two involved causal chains that were more indirect, e.g., a boy pumps a bicycle pump that is attached by a cord to a box holding a garden flower and when the boy pumps, the garden flower spins.

Familiarization events were shown four times (6s each presentation) on both sides of a large projection screen and were accompanied by a digitally synchronized auditory event description that included a novel verb. Novel verbs were presented in one of two syntactic frames: unergative (“The boy is blicking.”) or transitive (“The boy is blicking the flower.”). Note that in the unergative frame, the intransitive subject unambiguously labels the agent of the event. Each participant saw four different causative events and heard a different novel verb used to describe each event. Input frames (unergative vs. transitive) differed between subjects. A complete list of the causative events used as familiarization events is given in Table 1.

The contrast phase occurred between the third and fourth presentations of each familiarization event (Waxman 2004). At this time, participants saw an event in which the agent of the familiarized causative event engaged in a different, noncausative activity with the inanimate object. For the event involving the boy and the flower, for example, during the contrast phase, the boy held the flower in his hands and waved it from side to side. While watching contrast events, participants heard an event description that repeated the novel verb, but that pointed out that whatever event was encoded in the novel verb was not happening (“Oh no! Now the boy is not blicking.”).

Novel verb	Causative event	Repeated Means	New Means
Direct Causation			
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)
Indirect Causation			
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 1: Familiarization and test events by novel verb

In each of the four trials, the familiarization phase was followed by a test phase in which participants saw two new dynamic event scenes presented simultaneously on opposite sides of the screen and were directed by the auditory stimulus to find the event that could be labeled with the novel verb presented during familiarization. Both test events depicted the agent of the familiarized causative engaged in some noncausative activity (Table 1). In one of the test events, only the means subevent of the familiarized causative was repeated (Repeated Means test event), e.g., for the event involving the boy and the flower, in the Repeated Means test event the boy pumps the bicycle pump, but the flower doesn't 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), e.g., the boy waves his hand in front of the flower as if to spin it, but the flower doesn't actually spin. A schematic depiction of a representative trial, including specific examples of test events, is presented in Table 2.

Participant attention to the stimuli was videotaped using a digital video camera; research assistants who were not aware of the predicted responses coded participant videos for direction of visual fixation during the test phase.

3 Results and Discussion

The goal of this experiment was to find out whether young language learners use the identity of the event participant picked out by the subject of an intransitive sentence to guide their hypotheses about the meaning of novel intransitive verbs. In particular, we wanted to know whether 2-year-olds would be willing to interpret a novel verb in an unergative intransitive sentence as a label for the activity of the agent of a causative event. Previous studies have shown that participants in the intermodal preferential looking task tend to look longer at scenes that match the speech stimulus. In this study, then, 2-year-olds who have interpreted novel verbs as labels for an agent's activity should look longer at the Repeated Means test events when asked to find the test event that matches the novel verb.

To determine which of the test events these learners were willing to associate with the novel verbs presented during familiarization, we compared looking patterns from two 2s windows of the test phase: a 2s salience window and a 2s window around the first mention of the novel verb in the test audio. During the salience period, participants had not yet heard the novel verb repeated, and patterns of looking here provide 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: critically, 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.

Phase	Left side of screen	Right side of screen	Audio track
Familiar-ization	boy makes a flower spin by pumping a bicycle pump	black screen	Look! The boy is blicking. Do you see the boy blicking?
	black screen	boy makes a flower spin by pumping a bicycle pump	Wow! The boy is blicking. Do you see the boy blicking?
	boy makes a flower spin by pumping a bicycle pump	boy makes a flower spin by pumping a bicycle pump	Yay! The boy is blicking. Do you see the boy blicking?
Contrast	(centered) boy waves flower from side to side		Oh no! Now the boy is not blicking. The boy is not blicking.
Familiar-ization	boy makes a flower spin by pumping a bicycle pump	boy makes a flower spin by pumping a bicycle pump	Yay! Now the boy is blicking. Do you see the boy blicking?
Test	<u>Repeated Means</u> boy pumps (flower does nothing)	<u>New Means</u> boy hits flower (flower does nothing)	Oh look, they're different. Do you see blicking? Do you see blicking? Where's blicking now?

Table 2: Schematic depiction of stimulus design, Unergative condition

Figure 1 depicts the mean proportion of visual fixation toward the Repeated Means test event for each input condition (averaged across participants and trials). T-testing revealed differences across conditions in looking during the Salience window that approached significance, with participants in the Unergative condition looking longer at the New Means test event than participants in the Transitive condition (Unergative: .39, Transitive: .53, $t(21) = 1.94, p = .06$). We would expect this pattern of looking if our participants entered the test phase of each trial primed by their input during the familiarization phase to attend to certain event features. In the Unergative condition, if 2-year-olds interpreted the novel verb as a label for the activity the causative agent was engaged in, their initial preference for the New Means test event would reflect a novelty preference for the test event in which the agent was doing something different. In the Transitive condition, if learners were led by the transitive input frame to attend to the causal relationship between agents and affected objects (Bunger 2006, Lidz et al. 2004), both noncausative test events would have been novel.

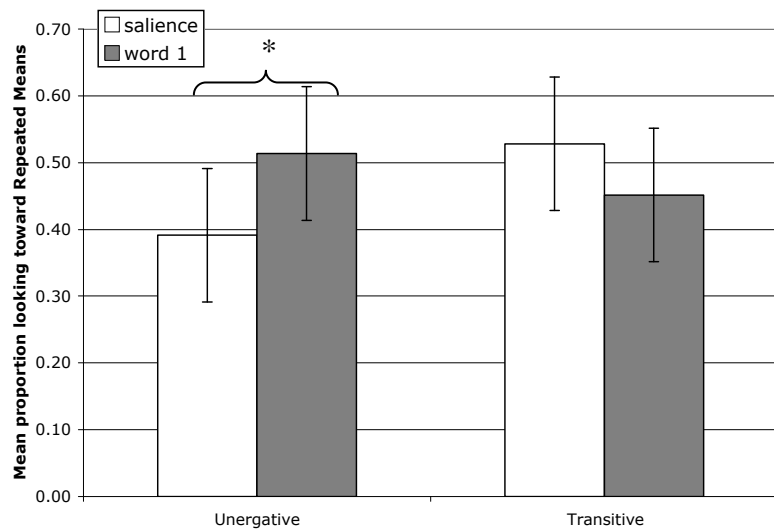


Figure 1: Mean visual fixation at test. *In the Unergative condition, mean looking during Word 1 is significantly different from looking during Salience for familiarization events involving indirect causation.

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 shift in their preference for the Repeated Means test event. This trend reached significance, however, only for trials in which the familiarization events had involved indirect causation (indirect (light, flower): $t(11) = -2.54, p = .028$; direct (ball, tower): $t(11) = .256, p = .8$).

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. 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), in the Repeated 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 (one of the more direct causatives), in the Repeated 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.

Recall that the verb in an unergative intransitive frame labels some activity that an agent is involved in: compare the novel verb input in (7a) with the English verb in (7b), 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.

- (7) a. The boy is blinking.
b. The boy is pumping.

The preference for the Repeated 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 activity of the agent of a complex causative event.

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 ($t(11) = -.85, p = .41$). 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.

4 Conclusions

These findings shed light on the nature of the syntactic cues 2-year-olds use to inform their hypotheses about verb meaning. Specifically, they demonstrate that 2-year-old language learners use information about the semantic role of event participants in addition to subcategorization information to narrow down their hypotheses about the meaning of a novel verb. For cases in which an input frame includes only one argument, as in the case of novel verbs in intransitive sentences, word learners of this age use information about the semantic role played by the event participant picked out by the intransitive subject to map that novel verb to an event.

Bunger and Lidz (2004) found that when the subject of an intransitive sentence corresponds to the entity undergoing the change of state in a causative event, children of this age interpret the verb as a label for the change of state undergone by that object. If 2-year-old learners in the current study had been using nothing more than the number of arguments in the input frame to drive their interpretation of novel verbs, then they, too, should have mapped one-argument verbs onto the result subevent of the complex causative. (In this case, because the result subevent was not repeated in either test event, neither should have provided a suitable match, and participants in the Unergative condition should have performed at chance.) Instead, our 2-year-olds mapped unergative intransitive verbs onto the activity of a causative agent, demonstrating that they were aware of the mapping between the subjects of the input sentences and the agents of the causative events.

Our results also shed some light on the subtle way that young word learners integrate information from multiple cues when mapping novel verbs to events. In this study, we found that 2-year-old learners were sensitive both to the frames in which novel verbs were presented and to the nature of the relationship between event participants: although our learners were able to map novel unergative verbs onto an agent's activity, they seemed to be unaware of changes in agent activities that preserved a familiarized relationship between the agent and some inanimate object. This finding illustrates one of the ways in which linguistic and extralinguistic input are integrated in verb learning. Further work will have to be done to determine

precisely which event features young verb learners are sensitive to, how they relate to semantic features we know to be relevant for verb meaning, and how a learner's initial biases change as she gains more exposure to her language and to the world.

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