

BUCLD 49 Proceedings
To be published in 2025 by Cascadilla Press
Rights forms signed by all authors

28-Month-Olds Use Inferred Thematic Relations to Bootstrap Intransitive Verb Meanings

Laurel Perkins, Victoria Mateu, and Nina Hyams

1. Introduction

Young children use a verb's syntactic distributions to draw inferences about the kinds of events that it labels; this is *syntactic bootstrapping* (Gleitman, 1990; Landau & Gleitman, 1985). The literature concerned with bootstrapping in its earliest stages has primarily focused on the inferences that learners draw from transitive clauses. Cross-linguistically, transitive clauses strongly tend to describe causal events, and toddlers as young as 20 months can exploit this information: they reliably infer causal meanings for new verbs in transitive frames (e.g., Naigles, 1990; Yuan, Fisher, & Snedeker, 2012; see Fisher, Jin & Scott, 2019 for a review). Even when toddlers hear a new verb in transitive clauses without an accompanying scene that provides candidate meanings, they retain that transitivity information, putting it to use when they later encounter a possible event referent (Arunachalam & Waxman, 2010; Arunachalam et al., 2013; Messenger, Yuan, & Fisher, 2015; Yuan & Fisher, 2009). These sensitivities to clause transitivity have provided important evidence that children exploit particular syntax-meaning correspondences for bootstrapping in early development (Fisher, Jin & Scott, 2019; Lidz & Gleitman, 2004; Naigles, 1990; Perkins et al., 2024).

Relatively less work has studied the inferences that toddlers draw on the basis of intransitive syntax, where correlations with meaning are more subtle (Bunger & Lidz, 2004; 2008; Scott & Fisher, 2009). Observing that a verb occurs with a single argument does not by itself provide strong constraints on its meaning. This is because intransitive clauses fall into two classes cross-linguistically: unergatives, whose sole argument behaves like a typical subject and names an agent of an event (1a); and unaccusatives, whose sole argument displays

*Laurel Perkins, Department of Linguistics, University of California Los Angeles, perkinsl@ucla.edu; Victoria Mateu, Department of Spanish and Portuguese, University of California Los Angeles, vmateu@humnet.ucla.edu; Nina Hyams, Department of Linguistics, University of California Los Angeles, hyams@humnet.ucla.edu. This work was supported by UCLA Faculty Senate grants to L.P., V.M., and N.H. We thank the UCLA Language Acquisition Lab, Gissell Alvarado, Minqi Liu, Evelyn Cortes-Gress, and our research assistants: Itzel Cerecedo, Sofia Duffy, Tina Fotouhi, Emily Freedman, Nicole Fuches, Gabriela Hernandez, Isabella Latcham-Radusky, Aileen Rodriguez, Ana Sofia Rodriguez, Wendy Rodriguez.

properties characteristic of a transitive object, and names a patient (1b). On many accounts these differences stem from a difference in underlying syntactic structure, in which the sole argument of an unaccusative clause is generated as an underlying object but surfaces as a subject (Burzio, 1986; Levin & Rappaport Hovav, 1995; Perlmutter, 1978).

- (1) a. The girl dusted. *unergative*
 b. The vase broke. *unaccusative*

Both of the intransitive sentences in (1a-b) might felicitously describe a complex scene: for instance, a girl dusts a lamp, causing it to break. A child encountering one of these verbs for the first time in such a context needs a way to identify the relevant aspect of the scene that it refers to. The thematic relation of the intransitive subject and the type of intransitive clause structure provide useful information. Cross-linguistically, verbs describing actions or activities of an agent tend to occur with arguments expressing that agent, and therefore are more likely to occupy unergative clauses; verbs describing events of change tend to occur with arguments expressing the patient of that change, and therefore to occupy unaccusative clauses (Levin & Rappaport Hovav, 1995; Sorace, 2000; Williams, 2015). If children are aware of these correlations, then they might be able to leverage them for bootstrapping verb meanings from intransitive syntax. For instance, a child who can identify the subject of (1a) as an agent, and the clause as unergative, might infer that it describes the girl's dusting, potentially independent of the change that it produces to the vase. Other events of dusting that do not cause changes might therefore be in the verb's extension. Conversely, a child who can identify the subject of (1b) as a patient, and the clause as unaccusative, might infer that it describes the vase's breaking, potentially independent of the action of the agent. Other breaking events that occur spontaneously might therefore be in the verb's extension.

There is wide variation in whether and how languages mark the distinction between these intransitive clause types, so children must learn how to identify them in the particular language that they are acquiring (Burzio, 1986; Huang, 1987; Torrego, 1989; Levin & Rappaport Hovav, 1995; Alexiadou et al., 2004). In languages where the unaccusative/unergative distinction is marked via auxiliary selection (*have* vs. *be*: Italian, French) or word order properties (pre-verbal vs. postverbal subjects: Mandarin, Spanish, Italian), children as young as 20 months to 3 years old show sensitivity to these morphosyntactic cues (Lin & Deen 2021; Mateu, Perkins, & Hyams 2023; Snyder & Hyams, 2015; Wang, Yang, & Shi, 2019). But a language like English provides learners with much poorer evidence. The English resultative construction is grammatical with unaccusatives but not unergatives (*The lake froze solid; *Anne yelled hoarse*). Otherwise, the two types of intransitives do not differ in auxiliary selection, word order, or other morphological marking. In a language with such little overt morphosyntactic evidence for this distinction, are young verb learners able to identify intransitive clause types reliably enough to feed their inferences about verb meaning? If so,

how?

Following a large body of prior work arguing that sensitivity to *animacy* guides early verb and grammar learning (Becker, 2006; 2014a; 2014b; 2015; Becker & Schaeffer, 2013; Bungler & Lidz, 2004; 2008; Childers et al., 2004; Scott & Fisher, 2009; a.o.), we pursue the hypothesis that children treat animacy as a probabilistic cue to the thematic relations of clause arguments, thereby constraining their bootstrapping inferences from intransitive syntax. In particular, because agents strongly tend to be animate, hearing an inanimate subject (as in 1b) might lead children to infer that it more likely names a patient than an agent. This may license the inference that the clause is unaccusative and describes an event of change (Becker & Schaeffer, 2013).

This hypothesis receives some support from earlier experimental findings. 24- to 28-month-old verb learners attend to the thematic relations of intransitive subjects when presented with a concurrent visual scene illustrating possible referents (Bunger & Lidz, 2004; 2008), or when this thematic information is reinforced by evidence from alternating transitive and intransitive frames (Scott & Fisher, 2009). In the current study, we show that 28-month-olds can bootstrap verb meanings (i) in the absence of referential context and (ii) from intransitive sentences alone. They do so by using animacy to infer the thematic relation of the intransitive subject, and by using thematic relations to infer whether a novel intransitive verb labels an event of change or an activity. Toddlers' sensitivities to the correlations between intransitive argument structure and meaning suggests early knowledge of the unergative/unaccusative distinction, even in a language where this distinction is not marked in the overt morphosyntax.

2. Background: Animacy and Intransitive Verb Learning

Children attend to animacy from a very young age, making it a salient source of information at early stages of language development. Infants in their first year of life are sensitive to animate entities' behavioral and physical characteristics, such as eyes, faces, hands, and self-propelled motion (Woodward, 1998; Saxe et al., 2005). They expect animate entities to engage in goal-directed and rational action, and be agents rather than recipients of change (Csibra et al., 2003; Kuhlmeier, Wynn & Bloom, 2003; Meuntner & Carey 2010; Woodward, 1998).

Because animacy is correlated with thematic relations—agents are more likely to be animate than inanimate—animacy provides a useful, albeit probabilistic, cue for syntactic structure. Agents are usually named by subjects of basic transitive clauses, and so subjects tend to be higher in animacy than objects cross-linguistically (e.g., Comrie, 1989). Children might thus be able to use animacy asymmetries as loose correlates of subject-object asymmetries. Becker (2014a) argues that children might expect subjects of all clauses to be animate, and treat inanimate subjects as a signal of displacement from a deep object position. Consistent with this hypothesis, preschoolers appear to use subject inanimacy to infer syntactic displacement in a variety of experimental tasks: 3-year-olds treat inanimate subjects as a signal that a novel predicate is a raising

rather than control verb, or a *tough*-like adjective rather than a control adjective (Becker, 2006; Becker, 2015; Becker, 2014b).

Subject (in)animacy may be a useful cue for differentiating unaccusatives from unergatives in verb learning. If young verb learners expect inanimate noun phrases to make poor agents, then hearing an intransitive clause with an inanimate subject might license the inference that it is describing an event of change to a patient rather than an activity of an agent, and thus is more likely to be unaccusative than unergative. Indeed, corpus studies of child-directed speech find that subject animacy is a strong predictor of the unaccusative/unergative distinction in English. Unergative verbs appear overwhelmingly with animate subjects, whereas unaccusative verbs allow both animate and inanimate subjects in intransitive clauses (Scott & Fisher, 2009). Children's speech displays the same distributional asymmetries when they begin producing their first unergative and unaccusative verbs (Becker & Schaeffer, 2013). This raises the possibility that early knowledge of the correlations between animacy, thematic relations, and intransitive clause type might underly the mechanisms by which these verbs are acquired.

Prior experimental studies provide some empirical support for this proposal. In a novel verb learning task, Bungler and Lidz (2004, 2008) found that 22- to 25-month-olds draw inferences from the thematic relations of intransitive subjects, when given an accompanying scene illustrating possible referents. For instance, Bungler and Lidz (2004) familiarized toddlers with a novel verb in the context of a scene in which a girl hits a ball, causing it to bounce. Toddlers were then tested on whether they would extend the verb's meaning to an event in which the ball bounced spontaneously, compared to an event in which the girl continued to pat the ball but effected no change (the ball remained immobile). Toddlers who heard the novel verb in an unaccusative frame during familiarization (e.g., *The ball is pimming*) looked longer at the bouncing event compared to the patting event at test. This suggests that they used the thematic relation of the intransitive subject to draw an inference about what kinds of events the verb describes: because the subject named the patient of the familiarization event, the verb likely described the change that the patient was undergoing.

In a follow-up study, Bungler and Lidz (2008) familiarized toddlers with a similar scene described by a novel verb in an unergative frame (e.g., *The girl is pimming*). At test, these toddlers looked longer at an event in which the girl hit the ball in the same way while the ball remained immobile, compared to an event in which the hitting was conducted by a different means. This suggests that hearing the intransitive subject label the agent of the familiarization event led toddlers to infer that the verb described a specific activity of that agent, independent of any change to the patient. Thus, when given a referential context, 2-year-olds are able to observe whether an intransitive subject labels an agent or patient of an event, and then use that thematic relation to draw inferences about the meaning of the verb in the clause.

Scott and Fisher (2009) tested toddlers' abilities to draw these inferences from verbs' syntactic distributions alone, without an accompanying visual scene. The

authors presented 28-month-olds with videos of women using novel verbs in conversation. The verbs alternated between transitive and intransitive clauses, with both the type of transitivity alternation and the animacy of the intransitive subject manipulated across conditions. One group of toddlers heard dialogues in which the verb participated in an unaccusative-transitive alternation (2a): the intransitive subject was inanimate and also appeared as the object of a transitive clause. Another group heard dialogues in which the verb participated in an unergative-transitive alternation (2b): the intransitive subject was animate and also appeared as the subject of a transitive clause.

- (2) a. Matt dacked the pillow. The pillow dacked.
b. Matt dacked the pillow. He dacked. (Scott & Fisher, 2009)

At test, both groups of toddlers were asked to find the referent of the novel verb out of two candidate events: an event of caused change to a patient (a girl pushes a boy, causing him to squat), and an activity of an agent that effects no change (a girl brushes a boy with a feather duster). Toddlers who had heard unaccusative-transitive dialogues (2a) preferred to look at the event of change, and toddlers who had heard unergative-transitive transitive dialogues (2b) preferred to look at the activity. Thus, even when first exposed to a novel verb without helpful visual information, toddlers appeared to use cues to the thematic relations of the intransitive subject to draw inferences about the verb's meaning.

There were two types of correlated cues that toddlers may have exploited in order to succeed in Scott and Fisher's (2009) task. They may have attended to the (in)animacy of the intransitive subject, or they may have attended to the degree to which the intransitive subject was co-referential with the subject or object of the transitive clauses. If toddlers assumed that the transitive and intransitive uses of the verb described the same event, and further knew that subjects of active transitive clauses name agents and objects name patients, then this would have given them another route for inferring the thematic relation of the intransitive subject. Because *the pillow* is a direct object, it likely names a patient in the transitive sentence in (2a), and thus it also likely names a patient in the intransitive sentence. Thus, these findings suggest that toddlers can use congruent evidence from animacy and transitive-intransitive alternations to infer thematic relations for verb learning. But they do not tell us which of these two types of information were primarily responsible for toddlers' inferences, or whether toddlers can make use of each type independently.

2.1. The Current Study

In the current study, we isolate the contribution of animacy in toddlers' intransitive verb-learning inferences. We test 28-month-olds on a similar dialogue-based preferential looking task as in Scott and Fisher (2009), presenting novel verbs in dialogues without an accompanying referential context. Unlike prior work, we present novel verbs in solely intransitive clauses, manipulating the

animacy of the intransitive subject as the only cue to its likely thematic relation. One group of toddlers hears intransitives with inanimate subjects (3), and a second group hears intransitives with animate subjects (4).

(3) A: The toy is gonna dax. *Inanimate-subject dialogue*
B: Really? It's gonna dax?

(4) A: The girl is gonna dax. *Animate-subject dialogue*
B: Really? She's gonna dax?

At test, we ask both groups of toddlers to find the referent of the novel verb in the context of the same two videos: a girl effecting a change of state to an object (e.g., breaking a toy), or a girl performing an activity that does not effect a change (e.g., wiping a toy). If toddlers can (i) use animacy alone to infer that the subject of (3) is more likely a patient, even without converging evidence from transitivity alternations or a visual referent, and (ii) know that intransitive clauses whose subjects are patients likely describe events of change (are unaccusative), then toddlers who hear the inanimate-subject dialogues in (3) should prefer the change-of-state video at test. If toddlers who hear the animate-subject dialogues in (4) infer that the subject likely names an agent, then they should not preferentially interpret the verb as an event of change. Thus, this task allows us to probe how robustly toddlers can use animacy information to infer thematic relations without an accompanying referential context, and deploy those inferred thematic relations in the service of bootstrapping intransitive verb meanings.

3. Method

3.1. Participants

Participants at time of writing included 46 typically-developing toddlers (target $n = 50$) recruited from the Los Angeles area through the University of California Los Angeles Developmental Subject Pool. Their mean age was 27;29 (range: 27;2 – 29;5). Participants had to have heard English during at least 80% of their waking hours. Six additional toddlers were recruited but excluded prior to analysis due to fussiness ($n = 5$), or equipment malfunction ($n = 1$). Informed parental consent was obtained following the protocols of the Institutional Review Board at UCLA.

3.2. Materials

Familiarization stimuli consisted of videos of 13-second dialogues between two female native English speakers. Each dialogue comprised four sentences containing a verb in the same intransitive frame. Two sets of dialogues with known intransitive verbs were filmed for training trials (*sleep, bounce*; two dialogues each). Two additional sets of dialogues with novel verbs were filmed for test trials (*dax, pim*; four dialogues each).

Test visual stimuli consisted of pairs of videos of a girl puppet performing actions with inanimate objects (see Figure 1). Two pairs of actions were used in training trials (SLEEPING/WAVING, BOUNCING/ROLLING a ball), and two pairs of actions were used in experimental trials (BREAKING/WIPING a toy, OPENING/JUMPING ON a box). Videos were edited in Adobe Premiere to be 3.5 seconds during the pre-test phase and 3 seconds during the test phase. Test audio stimuli were recorded by a female native English speaker using child-directed speech. Test audio and video were combined with the corresponding familiarization dialogues to create the trial structure in Table 1. Videos were looped during the preferential looking portion of the test phase, and each presentation of the test verb was timed to frame the looped actions, which began at the verb's offset. Two versions of each experimental trial were created, crossing novel verb (*dax*, *pim*) with action pair (BREAKING/WIPING, OPENING/JUMPING ON).

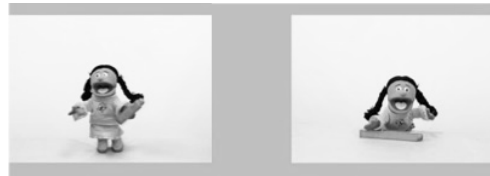


Figure 1. Sample test video stimuli: BREAKING/WIPING a toy

Table 1. Structure of a trial (inanimate-subject condition)

Phase	Audio	Video
Familiarization (4 dialogues)	- <i>Guess what? The toy is gonna dax!</i> - <i>Really? It's gonna dax?</i> - <i>Yeah, the toy is gonna dax!</i> - <i>No way! It's gonna dax!</i>	Two women conversing (13 s)
Pre-test	<i>Look at the girl and the toy!</i> <i>There they are again!</i>	Puppet breaks toy (4 s) Puppet wipes toy (4 s)
Test	<i>Now look what's happening!</i> <i>Do you see daxing?</i> <i>Where's daxing?</i>	Both videos loop twice (6.5 s) Blank screen (1.8 s) Both videos loop twice (6.5 s) Both videos loop twice (6.5 s)

3.3. Procedure

Stimuli were presented on a 46-inch widescreen television in a dimly-lit room. Toddlers sat on their parent's lap or in a high chair located 42 inches away from the television, and their gaze was recorded through a high-resolution videocamera located directly below the TV. Parents were instructed to close their eyes and to refrain from talking to their child or directing their attention. An experimenter in an adjacent room controlled the pan and zoom of the videocamera to ensure that the child's face stayed within the frame for the duration of the experiment. Each experiment lasted 5 minutes and 43 seconds.

Toddlers were randomly assigned to one of the two dialogue conditions

(Inanimate-Subject vs. Animate-Subject). In each condition, the experiment consisted of four trials, following the structure in Table 1. During the familiarization phase, toddlers heard a set of dialogues with the same verb in the same intransitive clause type, manipulated across conditions. During the pre-test phase, toddlers saw videos of two actions appearing one at a time on each side of the screen, with audio naming both the girl puppet and the object (e.g., *Look at the girl and the toy!*). During the test phase, both videos appeared simultaneously on a split-screen. The videos were first presented with uninformative audio (*Now look what's happening!*) to allow toddlers to adjust to the split-screen format. They then looped five more times while toddlers were directed to find the verb's referent. Following Yuan and Fisher (2009), the verb was presented as a gerund in both conditions so as not to provide any information about its syntactic distribution at test. This allowed us to measure whether toddlers could retain and later put to use the information about subject animacy that they had heard during the dialogue phase. Following Scott and Fisher (2009), the novel verb was presented twice, as previous work found that repetition of the test sentence was needed for toddlers to demonstrate comprehension in this type of task. The first presentation of the novel verb occurred during a blank grey screen to allow toddlers to parse the sentence without visual distractions.

The first two trials used known intransitive verbs (*sleep* and *bounce*), in order to familiarize toddlers with the experimental procedure before introducing novel verbs (Scott & Fisher, 2009; Yuan & Fisher, 2009). So as not to bias toddlers towards any particular intransitive clause structure, one of these training trials used unergative clauses (*The girl is gonna sleep*), and one used unaccusative clauses (*The ball is gonna bounce*), with order counterbalanced across participants. Consistent with each verb's syntactic frame, test videos for *sleep* presented two activities/controlled processes of an agent (SLEEPING vs. WAVING) and test videos for *bounce* presented two changes effected on a patient (BOUNCING vs. ROLLING a ball).

After the training trials, each toddler viewed two experimental trials, each presenting a different novel verb (*dax* and *pim*). For each verb, one test video depicted an event of change to a patient, and the other video depicted an activity of an agent that effected no change (BREAKING vs. WIPING a toy, or OPENING vs. JUMPING ON a box). Both order and the pairing of novel verb with candidate actions (BREAKING/WIPING, OPENING/JUMPING ON) were counterbalanced across participants. The left-right position of each candidate action was also counterbalanced across participants. Both training trials and experimental trials followed the structure in Table 1, but differed in length: training trials contained two dialogues each, and experimental trials contained four dialogues each. To re-focus toddlers' attention between trials, trials were interleaved with either a 5-second image of a baby's face with audio of a baby giggling, or a 14-second video of toys moving to music.

3.4. Predictions

If toddlers are able to use the animacy of the intransitive subject to infer its thematic relation when hearing dialogues containing novel verbs, and are further aware of how these thematic relations correlate with differences in intransitive syntax and verb meaning, then we predict that toddlers' looking behavior during the experimental trials will differ by dialogue condition. In particular, we predict that toddlers in the Inanimate-Subject condition should infer that the clause is unaccusative and the novel verb likely labels a change undergone by a patient. They should therefore look longer to the Change video compared to the Activity video when prompted to find the verb's referent at test. Toddlers in the Animate-Subject condition should infer that the clause is more likely unergative and the novel verb likely labels an activity of an agent, independent of a change effected on a patient; this predicts no preference for either video at test, because both depict an activity of an agent. If toddlers are unable to use animacy to infer thematic relations in the absence of a visual referential context, or are unaware of the correlations between intransitive clause type and meaning, then we predict that toddlers' preferences at test will not differ by condition.

4. Results

Toddler's gaze direction during the test phase of each experiment (left, right, or away from the screen) was coded frame-by-frame from muted videorecordings using Datavyu software (Datavyu Team, 2014). Data were coded by four experimenters, with intercoder reliability above 93%.

The two seconds following each presentation of the novel verb at test were selected as windows of analysis. At each frame, we calculated whether the toddler was looking towards the Change video (BREAKING, OPENING), the Activity video (WIPING, JUMPING ON), or neither. Trials were excluded if a toddler looked to the screen for less than 10% of the time in one or both of the 2-second windows of analyses; this resulted in 13 trials excluded out of 92 overall. For purposes of visualization, we plotted toddlers' average proportion of time spent looking to the Change video out of time spent looking to either video in each trial (Figure 2). Visual inspection reveals that toddlers' looking preferences differed by item. Toddlers' behavior appeared to diverge by condition in the expected direction for the BREAKING/WIPING item, with more looks to BREAKING over WIPING emerging after the second test sentence for toddlers in the Inanimate-Subject condition. However, toddlers' behavior did not appear to differ by condition for the OPENING/JUMPING ON item.

Toddlers' looking preferences during these windows of analysis were analyzed using a binomial mixed effects logistic regression with counts of frames spent looking to the Change video and counts of frames spent looking to the Activity video as the dependent variable. Unlike a proportion, this measure retains

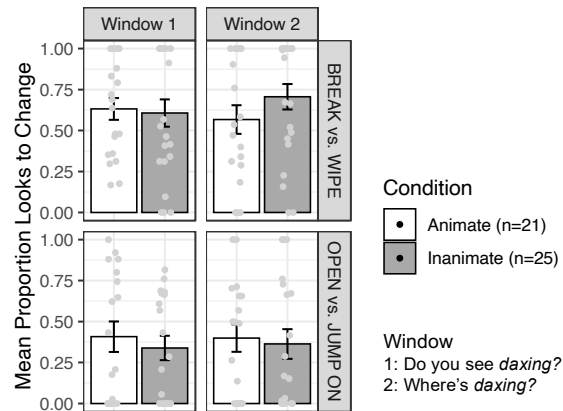


Figure 2. Mean Looking Time by Condition, Test Window, and Item

information about how much total data a particular toddler is contributing during a particular analysis window (Lidz, White & Baier, 2017; Perkins et al. 2024). Fixed effects included analysis window, condition, item, and their interactions. The maximal model that converged included a random intercept for subject and a random slope for window.

Significance testing was conducted through likelihood ratio tests, with fixed effects examined by comparing a model that contained the effect against a model that differed only in the absence of the effect. We found a significant main effect of item: toddlers preferred the Change video more for the BREAKING/WIPING item than for the OPENING/JUMPING ON item ($\chi^2(1) = 1383.20, p < 0.001$). We further found significant two-way interactions of window and item ($\chi^2(1) = 161.83, p < 0.001$), condition and item ($\chi^2(1) = 37.97, p < 0.001$), and importantly, a three-way interaction of condition, window, and item ($\chi^2(1) = 24.87, p < 0.001$). Post-hoc analyses using Z-tests, with a Bonferroni correction for multiple comparisons, revealed that toddlers in the Inanimate-Subject condition showed an increase in looks to the BREAKING video over the WIPING video between the first and second analysis windows ($Z = 2.09, p = 0.04$). Toddlers in the Animate-Subject condition showed no such increase ($Z = 0.61, p = 0.54$). That is, toddlers who heard dialogues with inanimate subjects, but not animate subjects, showed a predicted preference for BREAKING, with effects emerging after the second presentation of the novel verb. However, toddlers showed no increased preference for the OPENING video over the JUMPING ON video in either the Inanimate-Subject ($Z = -0.99, p = 0.32$) or the Animate-Subject condition ($Z = 0.20, p = 0.84$), showing a strong preference instead for the JUMPING ON video in both windows in both conditions.

Thus, although an effect is present for only one of the test items, we find evidence that toddlers who heard a novel intransitive verb in dialogues with inanimate subjects preferentially interpreted it as an event of change: BREAKING rather than WIPING.

5. Discussion

In this paper, we examine toddlers' abilities to use the syntactic distribution of an intransitive verb to infer aspects of its meaning, isolating the role that animacy plays in guiding these inferences. We find that English-learning 28-month-olds draw different inferences about a novel verb based on its distribution in intransitive clauses with animate vs. inanimate subjects, without an accompanying visual scene illustrating possible meanings. They are able to put this distributional evidence to use when they later encounter possible event referents. Toddlers who heard a verb in intransitive clauses with inanimate subjects preferred to map it to an event of change to a patient (a girl breaking a toy) compared to an activity that effected no change (a girl wiping a toy). Toddlers who heard the verb in intransitive clauses with animate subjects did not show this preference. Both groups of toddlers heard the verb in the same uninformative syntactic frame while viewing these candidate events. Thus, the different behavior that we observe between groups can only be attributed to what they learned about the verb from hearing it distribute in different types of sentences, before any visual referents were present.

These results suggest that 28-month-olds can (i) use animacy to infer whether the subject of an intransitive clause likely names an agent or a patient in an event, and (ii) use these thematic relations to infer whether the clause's verb likely labels an event of change, even without support from a concurrent referential context. Toddlers' awareness of the correlations between intransitive argument structure and meaning suggests knowledge of the unaccusative/unergative distinction. Their behavior is predicted under the hypothesis that they took the inanimacy of an intransitive subject as a signal that it named a patient, and therefore originated in a deep object position (Becker & Schaeffer, 2013). If English-speaking 28-month-olds represent clauses like *The toy is daxing* as deeply unaccusative and *The girl is daxing* as unergative, these syntactic representations would predict different inferences about the event types that they describe: specifically, whether they describe events of change versus activities of agents. This prediction is borne out in our experiment, supporting the hypothesis that children have early and sophisticated abilities to differentiate these clause types, even in a language where this distinction is not marked in the overt morphosyntax.

However, it is also possible that toddlers' interpretations of these sentences reflect more surface-level inferences based only on the different thematic relations of the subjects in these clauses, without necessarily representing those clause arguments as originating in different syntactic positions. For instance, toddlers may have inferred that a clause whose sole argument names a patient is likely to describe an event of change to that patient (Williams, 2015), without representing the underlying syntax of that clause differently from a clause whose sole argument names an agent. This finding therefore invites further work probing toddlers' syntactic representations of unaccusative and unergative clauses at this age, a question which has broader consequences for whether very young learners take differences in thematic relations to also indicate differences in deep syntactic

positions—that is, whether they have knowledge of linking principles between thematic content and syntactic structure that hold robustly in adult grammars cross-linguistically (Baker 1997; Burzio, 1986; Levin & Rappaport Hovav, 1995; Perlmutter, 1978).

Further work is also needed to determine why an effect was only observed for one of the two test items. Toddlers mapped intransitive verbs with inanimate subjects to BREAKING as opposed to WIPING, but not to OPENING as opposed to JUMPING ON. One possibility is that toddlers' knowledge about correlations between subject animacy and verb meaning is specific to BREAKINGS. They may know that verbs of breaking can distribute in intransitive clauses with inanimate subjects, but this knowledge may not generalize to other verbs of change. Alternatively, perhaps they did not view the OPENING scene as a clear event of change: unlike BREAKING, the OPENING event did not alter the basic structure of the box. However, we think a more plausible explanation is that there were differences in visual salience between the OPENING and JUMPING ON scenes: toddlers in both conditions showed a strong and persistent preference for the JUMPING ON video. If toddlers found the JUMPING ON video to be independently more interesting than the OPENING video, then this difference may have masked any effect of dialogue condition. Controlling for salience confounds will allow future work to determine whether toddlers' inferences are based on general knowledge of how intransitive clause types correlate with event types, or on more specific knowledge about BREAKINGS in particular.

More broadly, this result contributes to a growing body of literature on children's sensitivity to animacy and thematic content in early verb and grammar learning (Becker, 2014a; 2014b; 2015; Becker & Schaeffer, 2013; Bunker & Lidz, 2004; 2008; Perkins et al., 2024; Scott & Fisher, 2009). We find that toddlers are able to infer the thematic relations of clause arguments in order to constrain their inferences about verb meanings, in such a way that they can draw sophisticated inferences from intransitive clauses whose sole arguments appear in the same surface syntactic position, and differ only in their animacy. This finding provides support for the hypothesis that the unaccusative/unergative distinction is represented early in development. It further provides converging evidence for proposals that children's early bootstrapping mechanisms are underwritten by rich knowledge of principles linking the thematic relations of clause arguments to the meanings that a clause's verb expresses (Baker, 1997; Dowty, 1991; Perkins et al., 2024; Pinker, 1984, 1989; Williams, 2015).

References

- Alexiadou, Artemis, Elena Anagnostopoulou, & Martin Everaert (Eds.). (2004). *The unaccusativity puzzle: Explorations of the syntax-lexicon interface* (Vol. 5). Oxford University Press, USA.
- Arunachalam, Sudha, Emily Escovar, Melissa A. Hansen, & Sandra R. Waxman. (2013). Out of sight, but not out of mind: 21-month-olds use syntactic information to learn verbs even in the absence of a corresponding event. *Language and Cognitive Processes*, 28(4), 417–425.

- Arunachalam, Sudha & Sandra R. Waxman. (2010). Meaning from syntax: Evidence from 2-year-olds. *Cognition*, 114(3), 442–446.
- Baker, Mark C. (1997). Thematic roles and syntactic structure. In Liliane Haegeman (Ed.), *Elements of grammar* (pp. 73–137). Springer.
- Becker, Misha. (2006). There began to be a learnability puzzle. *Linguistic Inquiry*, 37(3), 441–456.
- Becker, Misha. (2014). *The acquisition of syntactic structure: Animacy and thematic alignment* (Vol. 141). Cambridge University Press.
- Becker, Misha (2014). Animacy and the acquisition of *tough* adjectives. *Language Acquisition*, 22(1), 68–103.
- Becker, Misha. (2015). Learning structures with displaced arguments. In Andreas Trotzke & Josef Bayer (eds.) *Syntactic Complexity across Interfaces*, 30, 193–227. De Gruyter Mouton.
- Becker, Misha & Jeannette Schaeffer (2013). Animacy, argument structure and unaccusatives in child English. In Misha Becker, John Grinstead, & Jason Rothman (Eds.) *Generative linguistics and acquisition: Studies in honor of Nina M. Hyams*, 13–54. John Benjamins Publishing Company.
- Bunger, Ann & Jeffrey Lidz. (2004). Syntactic bootstrapping and the internal structure of causative events. In Alejna Brugos, Linnea Micciulla & Christine E. Smith (eds.) *Proceedings of the 28th annual Boston University Conference on Language Development*. 74–85. Somerville, MA: Cascadilla Press.
- Bunger, Ann & Jeffrey Lidz. (2008). Thematic relations as a cue to verb class: 2-year-olds distinguish unaccusatives from unergatives. *University of Pennsylvania Working Papers in Linguistics* 14(1). 4.
- Burzio, Luigi. (1986). *Italian syntax: A government-binding approach*. Netherlands: Springer.
- Childers, Jane B. & Catharine H. Echols. (2004). 2 1/2-year-old children use animacy and syntax to learn a new noun. *Infancy*, 5(1), 109–125.
- Comrie, Bernard. (1989). *Language universals and linguistic typology*. University of Chicago Press.
- Csibra, Gergely, Szilvia Bíró, Orsolya Koós, & György Gergely. (2003). One-year-old infants use teleological representations of actions productively. *Cognitive Science*, 27(1), 111–133.
- Datavyu Team (2014). Datavyu: A Video Coding Tool. Databrary Project, New York University. <http://datavyu.org>.
- Dowty, David. (1991). Thematic proto-roles and argument selection. *Language* 67(3), 547–619.
- Fisher, Cynthia, Kyong-sun Jin, & Rose M. Scott. (2019). The developmental origins of syntactic bootstrapping. *Topics in Cognitive Science*, 12(1), 48–77.
- Gleitman, Lila R. (1990). The structural sources of verb meanings. *Language Acquisition*, 1(1), 3–55.
- Huang, C.-T. James. (1987). Existential sentences in Chinese and (in)definiteness. In Eric Reuland & Alice ter Meulen (eds.) *The representation of (in)definiteness*, 226–253. Cambridge, MA: MIT Press.
- Kuhlmeier, Valerie, Karen Wynn, & Paul Bloom. (2003). Attribution of dispositional states by 12-month-olds. *Psychological Science*, 14(5), 402–408.
- Landau, Barbara & Gleitman, Lila R. (1985). *Language and experience: Evidence from the blind child*. Harvard University Press.
- Levin, Beth & Malka Rappaport Hovav. 1995. *Unaccusativity: At the Syntax-Lexical Semantics Interface*. Cambridge, MA: MIT Press.

- Lidz, Jeffrey & Lila R. Gleitman. (2004). Argument structure and the child's contribution to language learning. *Trends in Cognitive Sciences*, 8(4), 157–161.
- Lidz, Jeffrey, Aaron Steven White, & Rebecca Baier. (2017). The role of incremental parsing in syntactically conditioned word learning. *Cognitive Psychology*, 97, 62–78.
- Lin, Kai-ying & Kamil Ud Deen. (2021). Unaccusativity in Mandarin Child Language. In Danielle Dionne & Lee-Ann Vidal Covas (Eds.), *Proceedings of the 45th annual Boston University Conference on Language Development*, 486–498. Somerville, MA: Cascadilla Press.
- Mateu, Victoria, Laurel Perkins, & Nina Hyams. (2023). Learning unaccusativity: Evidence for split intransitivity in child Spanish. *Proceedings of the Linguistic Society of America*, 8(1), 5557–5557.
- Messenger, Katherine, Sylvia Yuan, & Cynthia Fisher. (2015). Learning verb syntax via listening: New evidence from 22-month-olds. *Language Learning and Development*, 11(4), 356–368.
- Muentener, Paul & Susan Carey. (2010). Infants' causal representations of state change events. *Cognitive Psychology*, 61(2), 63–86.
- Naigles, Letitia R. (1990). Children use syntax to learn verb meanings. *Journal of Child Language*, 17(2), 357–374.
- Perlmutter, David M. (1978). Impersonal passives and the unaccusative hypothesis. In *Annual meeting of the Berkeley Linguistics Society* 4, 157–190.
- Perkins, Laurel, Tyler Knowlton, Alexander Williams, Jeffrey Lidz. (2024). Thematic content, not Number Matching, drives syntactic bootstrapping. *Language Learning and Development*. Advance online publication.
- Pinker, Steven. (1984). *Language learnability and language development*. Harvard University Press.
- Saxe, Rebecca, J. B. Tenenbaum, & Susan Carey. (2005). Secret agents: Inferences about hidden causes by 10- and 12-month-old infants. *Psychological Science*, 16(12), 995–1001.
- Scott, Rose M. & Cynthia Fisher. (2009). Two-year-olds use distributional cues to interpret transitivity-alternating verbs. *Language and Cognitive Processes* 24(6), 777–803.
- Sorace, Antonella. 2000. Gradients in auxiliary selection with intransitive verbs. *Language* 76(4), 859–890.
- Snyder, William & Nina Hyams. (2015). Minimality effects in children's passives. In Elisa Di Domenico, Cornelia Hamann & Simona Matteini (eds.) *Structures, Strategies and Beyond. Studies in Honour of Adriana Belletti*. 343–368. Philadelphia, PA: John Benjamins Publishing Company.
- Torrego, Esther. (1989). Unergative-unaccusative alternations in Spanish. *MIT working papers in linguistics* 10, 253–272.
- Wang, Ziqi, Xiaolu Yang & Rushen Shi. (2019). Mandarin-speaking toddlers' acquisition of unaccusativity. In Megan M. Brown & Brady Dailey (eds.) *Proceedings of the 43rd Boston University Conference on Language Development*, 705–715. Somerville, MA: Cascadilla Press.
- Williams, Alexander. (2015). *Arguments in syntax and semantics*. Cambridge University Press.
- Woodward, Amanda L. (1998). Infants selectively encode the goal object of an actor's reach. *Cognition*, 69(1), 1–34.
- Yuan, Sylvia & Cynthia Fisher. (2009). "Really? She blicked the baby?": Two-year-olds learn combinatorial facts about verbs by listening. *Psychological Science*, 20(5), 619–626.
- Yuan, Sylvia, Cynthia Fisher, & Jesse Snedeker. (2012). Counting the nouns: Simple structural cues to verb meaning. *Child Development*, 83(4), 1382–1399.