

UC Merced

Proceedings of the Annual Meeting of the Cognitive Science Society

Title

The Structural Alignment and Comparison of Events in Verb Acquisition

Permalink

<https://escholarship.org/uc/item/2jz052xr>

Journal

Proceedings of the Annual Meeting of the Cognitive Science Society, 30(30)

ISSN

1069-7977

Author

Childers, Jane B.

Publication Date

2008

Peer reviewed

The Structural Alignment and Comparison of Events in Verb Acquisition

Jane B. Childers (jane.childers@trinity.edu)

Department of Psychology, One Trinity Place
San Antonio, TX 78130 USA

Abstract

Three studies are the first to explore how Gentner's structural alignment theory (1983;1989) can be applied to the problem of verb acquisition. Study 1 shows that children younger than 3 can compare events based on consistencies across events, and that this comparison influences their extension of new verbs at test. Study 2 provides preliminary evidence that children can align events based on the relations present in related events. Study 3 shows that particular object changes (i.e. tool changes) across related events influences children's verb extensions. These results suggest that structural alignment and comparison may be a key mechanism in early verb learning.

Keywords: verb acquisition; domain-general mechanism; comparison; language acquisition.

Introduction

Learning a new verb is difficult. To learn a verb, children need to deduce which elements of a dynamic, transient event are important in a particular new verb's meaning or solve a "packaging problem" (e.g., Gleitman & Gleitman, 1992). Furthermore, languages vary in which elements of events are incorporated in their verb system (e.g., path information in verbs in Spanish but not as often in English; Talmy, 1975), thus children need to attend to different elements in events across languages.

Structural Alignment and Comparison

Given the difficulty of this task, it seems likely that children exploit any information available to them during verb learning, including information available in the situational context in which a new verb is heard. At the same time, considering every situational cue in every context would quickly overwhelm a young child. Thus, a principled account of how children use situational information across contexts is needed. Gentner and others have shown that adults and children can use a domain-general cognitive process to compare instances to each other (e.g., Markman & Gentner, 1993; Gentner & Markman, 1997; Gentner & Namy, 2000; Loewenstein & Gentner, 2001; Paik & Mix, 2006; Waxman & Klibanoff, 2000). In this view, an observer analyzes objects and their relations in one instance (e.g., propositions, spatial layouts, scenes) and then seeks out objects in the second instance that can be aligned to the first instance based on their common relational structure. This comparison process highlights the common relational structure across instances (Gentner & Markman, 1997), which is just the sort of information children need to attend to when learning a new verb. Thus, this theory of structural alignment and comparison seems especially well suited to

describe a cognitive process children engage in when learning a new verb.

However, most studies of early verb learning in the laboratory expose the child to a single example of a new event. This may lead children to form a good understanding of that event, but also means that the cross-situational information children may be using during verb learning is not available during the experimental session. A few previous studies have provided children with multiple events linked to a single new verb. Two of these studies show that children who are as young as 3 can infer that a single element that *varies* across events must not be central to a new verb's meaning (Forbes & Farrar, 1995; Behrend, 1995). A third study (Gropen, Pinker, Hollander & Goldberg, 1991) adds that 4-year-olds are able to use contrastive information during verb learning (e.g., "Now let me show you something that is not keating") to shape their later verb productions. However, to argue that children are comparing contexts to each other and deriving a common relational structure (as predicted by Gentner's structural alignment view, e.g., Gentner, 1983; 1989) it is important to show that young children can attend to *consistency* across contexts.

Study 1 demonstrates that 2 1/2 year old children can attend to *consistencies* across related events, a prerequisite for the application of Gentner's view to verb learning. Studies 2 and 3 extend Study 1 by testing specific predictions that can be made by applying Gentner's theory to verb learning. Specifically, Study 2 tests 2 1/2-year-olds' attention to relations apart from objects to begin to better understand whether children can attend to relations or have undergone a 'relational shift'. Study 3 examines children attention to changing elements across events, as well as their use of syntactic information, during verb learning. As a whole, these studies begin to test a new mechanism for verb learning, a domain-general process of structural alignment and comparison.

Study 1

Method

Participants Thirty-six 2 1/2 year old children participated in this study (range: 2;4-2;10; mean age = 2;7) with 18 girls and 18 boys.

Children lived in a south central region of the United States, and were mostly from middle-class or upper-middle-class families. A 50% English criterion was used to exclude children with insufficient English exposure, and parents completed selected portions of the MacArthur-Bates Communicative Development Inventory: Words and Sentences (Fenson, Dale, Reznick, Bates, Thal, & Pethick,

1994) to provide an estimate of the child's language development.

Design and Materials Each child was randomly assigned to either a Control group, an Action group or a Result group (n= 12 per group). Verbs were presented in a random order across participants.

Four novel complex events were constructed and a novel verb (*tam, pilk, meek, gorp*) was randomly assigned to each event. Each novel complex event was created to include both an action component and a result component. A separate set of objects was used to show a series of related events depicting either consistent actions (with variations in results) or consistent results (with varying movements). A third set of stimuli including objects that could be used to preserve the action component, preserve the result component, or imitate the adult, was given to the child for his/her own enactment of the event at test. All of the events were designed as prototypical events (e.g., Slobin, 1981) in that they all had an animate agent (the experimenter or child) who acted on an inanimate patient (e.g., an egg).

For example, in one event, an object is rolled down an incline and disappears into a box. The action component of this complex action included rolling the object with one's fingers; the result was that the object was hidden (see Fig. 1). In the 3 action events the object was rolled in different ways and the result of disappearance was not present (e.g., rolling down an open tube). The 3 result events consisted of hiding the object in ways that did not include the motion of rolling (e.g., hiding in a bag). At test children were the box with the flap which could be used for imitation, a ramp which could be used to enact rolling and a cloth which could be used to enact hiding.

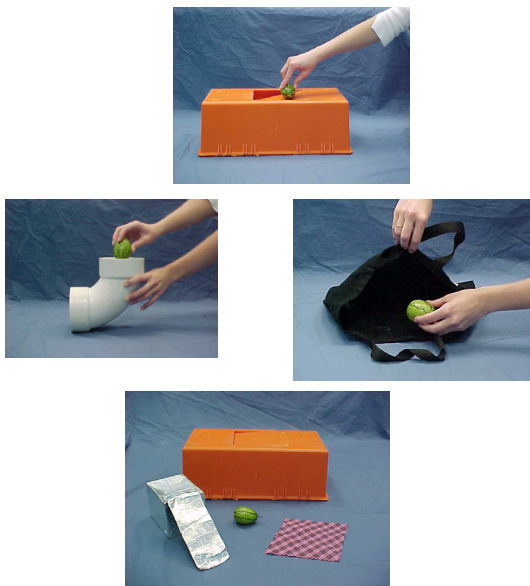


Fig. 1: Target event (top), Action comparison (left), Result comparison (right), Test objects (bottom).

Procedure Each child heard 4 new verbs. Each new verb was presented in a block of trials that included a teaching phase and a test phase. In the teaching phase, the

experimenter (E) enacted the target action while producing a novel verb (e.g., "Look! I'm going to <verb> it. I'm <verbing> it. I <verbed> it."). The set of sentences with the enactment was repeated. Children then were given a chance to enact the event and say the new verb (e.g., "Now it's your turn to play. Can you say ____?").

Following the child's enactment, the experimenter either repeated the target action 6 more times (Control group) or enacted 3 new events that were related to the target action. These new events either maintained the action component of the target event (Action group) or the result (Result group). For each new event, E produced the same set of 3 sentences twice and enacted the event twice (=24 repetitions of each novel verb before test).

In the test phase, the experimenter put new objects in front of the child and asked the child to enact the event (e.g., "Can you <verb> it?"). Each test set of objects included the apparatus used in the target event, a new object that could be used to enact the action, and a new object that could be used to produce the result (see Fig. 1). Once the child acted, the experimenter asked the child to produce the verb (e.g., "What are you doing?") and then the experimenter imitated the child's actions and asked the child to produce the verb again (e.g., "Now look. What am I doing?"). Children then were given one more chance to perform a new action (e.g., "Can you <verb> again? How else can you <verb> it?").

The teaching and test phase formed a single block of trials. The process was repeated until children had completed a block of trials for each of the four novel events. **Coding** Responses in which children used the target apparatus and performed the target action were coded as Target responses. Action responses were responses in which the child used new objects and performed the same movement as seen in the Target event (and comparison events). Result responses included any response in which children used a new object to accomplish the same result that was produced in the initial complex event (and comparison events). Any irrelevant responses were coded as Other.

To better examine the range of different responses children produced, only the first production of a particular type of response was scored (e.g., Meltzoff, 1995). Even so, in this study and in the subsequent studies children had the opportunity to make multiple responses, thus these response categories are independent.

Interrater agreement between 2 independent coders was 91%, Cohen's Kappa =.81.

Results

Preliminary analyses revealed that our 2 1/2-year-old children had difficulty learning 4 new verbs in a single session. Thus, we examined their responses to the first 3 verbs they heard in the experiment, with different children learning different combinations of the four new verbs.

A repeated measures ANOVA was computed with Response Type (3: Target, Action, Result) as a within-subjects factor, and Condition (3: Control, Action, Result) as a between-subjects factor; the dependent measure was the

number of responses produced at test (see Figure 2). The ANOVA revealed a main effect of Response Type, $F(2, 33) = 9.45, p < .001$, a main effect of Condition, $F(2, 33) = 5.50, p < .01$, and a significant Response by Condition interaction, $F(4, 33) = 6.86, p < .001$.

Simple comparisons with Sidak corrected p values for the use of multiple post-hoc tests (Sidak, 1967) were used to investigate the Response by Condition interaction (see Fig. 2). In the Control condition, there were significantly more Target responses than Action responses ($p < .001$). In the Result condition, there were significantly more Target and Result responses than Action responses ($p < .001$). There were no differences between the three response types in the Action condition.

These same analyses across the 3 conditions revealed no differences in the mean number of Target responses across conditions. The number of Action responses was greater in the Action condition than in the Control ($p = .001$) or Result conditions ($p = .001$). Result responses were greater in the Result condition than in both the Control condition ($p < .01$) and the Action condition ($p < .05$).

We also examined children's responses as individuals by counting how many children produced a Target, Action or Result response at test; the parametric results are mirrored in the responses made by individual children.

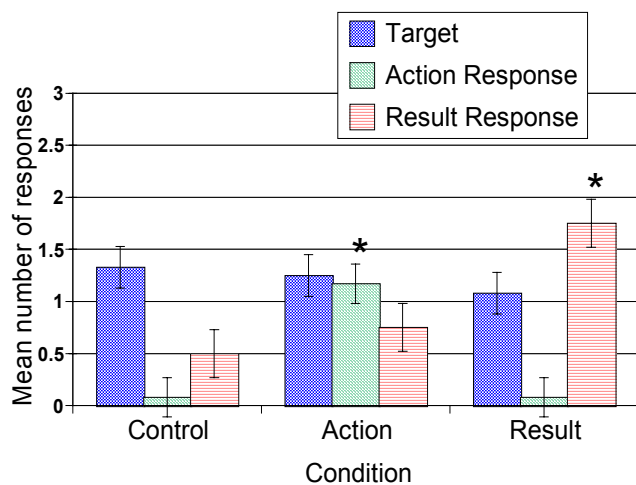


Fig 2: Study 1 Results.

Discussion

In this study, children who saw consistent actions or results preserved the consistent action or result in their enactments, extending the verb appropriately using new objects. These results are important because they demonstrate that children younger than 3 can compare events in terms of the consistent elements across events. They also suggest that comparing events may help children overcome a conservative tendency in verb learning (e.g., Tomasello, 1992) and generalize a newly learned verb. At the same time, studies are needed to directly test predictions that derive from the structural alignment view. Specific predictions are tested in studies 2 and 3.

One prediction that follows from the structural alignment view is that events with the same number of elements, and events with elements that accomplish a result in a similar way, are easier to align than are events in which variations in number and roles of elements are seen. In Study 2 we examined whether we could influence verb learning by giving children sets of either perfectly alignable or less alignable events.

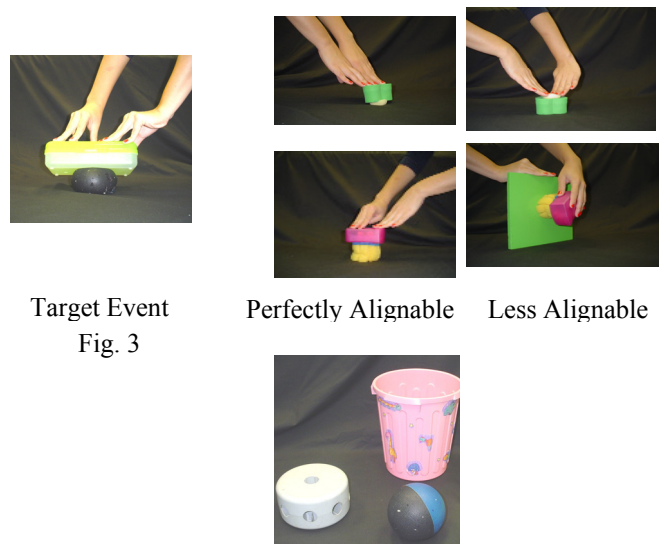
Study 2

Method

Participants Thirty-six 2 1/2-year-old children (mean age = 2;8; range: 2;5-2;10) participated in the study.

Design and Materials Twelve participants were randomly assigned to either a Perfectly Alignable, a Less Alignable or a Control Condition.

As in the previous study, 4 novel complex events were constructed as Target events (see Fig. 3) and a novel verb was randomly assigned to each event. In each target event, E used a specific movement/set of movements to create a noticeable change in a third object. In the Perfectly Alignable condition, 3 comparison events were constructed which had the same number of elements as in the Target event (and the other comparison events) and had objects in particular roles in each event (e.g., tools) that had similar perceptual properties. In the Less Alignable condition, the



Target Event
Fig. 3

Perfectly Alignable

Less Alignable

Test objects:
Extension (L), Affordance Object (R)

comparison events had different numbers of objects, the objects in particular roles did not share many properties, and some role reversals were shown (in terms of objects of a particular type in a role that was similar to a role in the target event, e.g., squisher, squishee). In a Control condition, the Target event was repeated twice. A third set of stimuli was available at test. These included an object that could be used to reproduce the result (Extension) and an object that could be used to perform a familiar unrelated

action (Affordance). The procedure was the same as had been used in Study 1.

Coding Children's responses were coded into three categories: as Extension responses (if they reproduced the event E had shown using new objects), as Affordance responses (if they used a familiar object to enact a familiar event, e.g. throwing a ball into a bucket above) or Other (if they enacted an irrelevant event). Children could respond multiple times thus they could produce all of the types of responses. In this study, we computed proportions of Extension and Affordance responses by counting the total number of each specific response type and dividing it by the total number of all responses.

Results

A repeated measures ANOVA was computed with Condition (Perfectly Alignable, Less Alignable, Control) as a between-subjects factor, and Response type (Extension, Affordance) as a within-subjects factor; the dependent measure was the proportion of responses at test. The analysis revealed a main effect of Response type, $F(1, 33) = 52.85, p < .001$, and a significant Condition by Response type interaction, $F(2, 33) = 5.04, p < .02$ (see Fig. 4).

Post-hoc tests showed that there were significantly more Extension responses in the Perfectly Alignable than in the Less Alignable condition ($p < .05$), but that Extensions in the Perfectly Alignable condition did not differ from the proportion of Extensions in the Control condition. In addition, there were significantly more Affordance responses in the Less Alignable condition than in the other 2 conditions ($p_s < .04$).

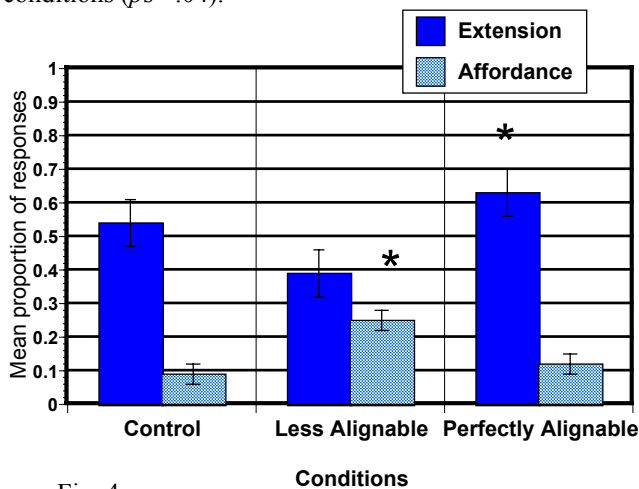


Fig. 4

Discussion

These results show that children performed less well when they saw events with differing numbers of elements, events in which the result was accomplished in a different way and/or events in which elements that shared properties with elements in a target event (e.g., the larger object in an event) was used in a different role in the comparison event. An account of why these types of successive events would be less useful to children is Gentner's (1983; 1988)

structural alignment view. This finding that we can disrupt alignments, as shown by children's increased reliance on a fall-back strategy (using object affordances) is exciting because no previous study of verb learning has shown attention to relations across events.

A second prediction that follows from the structural alignment view is that the comparison events will help children attend to the changing element in an event. In a third study children were shown either events in which a tool changed or a patient (affected object) changed across the comparison events. The prediction was that children who were comparing events to each other would attend to the changing element and use it to guide their verb extensions at test. In addition, in this study children received syntactic cues which should highlight objects that are named. Thus, the study includes comparison cues and syntactic information to explore the contribution of each type of information to verb learning.

Study 3¹

Method

Participants Forty-two 2 1/2-year-old children (mean age = 2;7; range: 2;4-3;3) participated in the study.

Design and Materials Each child was randomly assigned to either a Noun First, a Noun Last or an All Pronoun condition (n = 14 per condition). Within each condition, there were two within-subjects variables: Event type (tool change or patient change) and Response type (extension, distractor). Each child saw 2 sets of events in which the tool was changed in the events before test, and 2 sets of events in which the patient (affected objects) varied. While they were seeing these events, stimulus sentences either labeled the tool (Noun first), labeled the patient (Noun last) or neither (all pronoun). These different syntactic conditions were included to compare the effect of hearing a noun to the effect of seeing a changing element.

As in the previous studies, 4 novel events were constructed as Target events and a novel verb was randomly assigned to each event. In each target event, E used a specific movement/set of movements to create a noticeable change in a third object. Two event sets were created in which the patient was varied. For example, in one event, E stirred a set of smaller objects using a pencil (see Fig. 5). Two other event sets were created in which the affected object stayed the same but the tool changed (see Fig. 6). Children saw the related events while hearing sentences from one of the 3 sentence conditions.

Procedure The only difference in procedure in this study as compared to the previous 2 studies was that children were given an initial play session with the test objects to have the chance to explore them before each event set was shown.

As in the previous studies, children then heard 4 new verbs, one at a time. Each new verb was presented in a block of trials that included a teaching phase and a test phase. The sentences used in the teaching phase were those

¹Lashelle Sydenham and Cynthia Luethcke are co-authors on this study.

that corresponded to each child’s sentence condition. Each child saw 3 related events before the test phase and each event was demonstrated twice by E.



Noun First
“The pencil meeks it.”

Noun Last
“It meeks the rocks
(flowers, buttons).”

All Pronoun
“It meeks it.”

Fig. 5: Patient change set with sentence conditions.



Noun First
“The fork (brush,
banana) koobs it.”

Noun Last
“It koobs the cord.”

All Pronoun
“It koobs it.”

Fig. 6: Tool change set with sentence conditions.

In the test phase, the experimenter put new objects in front of the child and asked the child to enact the event (e.g., “Can you <verb> it?”). Each test set of objects included a new tool, a new patient and two distractor objects (see Fig. 7). Once the child acted, the experimenter asked the child to produce the verb (e.g., “What are you doing?”). Children then were given one more chance to perform a new action (e.g., “Can you <verb> again? How else can you <verb> it?”).

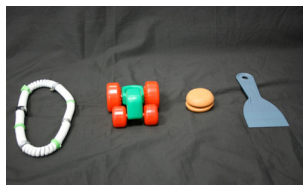


Fig. 7: Test objects for one of the tool change sets:
New object to stretch, distractor, distractor, new tool.

The teaching and test phase formed a single block of trials. The process was repeated until children had completed a block of trials for each of the four novel events. **Coding** Children’s enactments were coded into two main categories: Extension response (i.e., use of a new object to accomplish the same result as in E’s events) or Distractor (any other irrelevant response). As in Study 1, to better examine the range of different responses children produced, only the first production of a particular response was scored (e.g., Meltzoff, 1995). Even so, children could make multiple responses so the production of an extension

response did not mean they could not also make a distractor response.

Results

A repeated measures ANOVA was computed with Condition (3: Noun first, Noun last, All pronoun) as a between-subjects factor and Event Type (Patient change, Tool change) and Response Type (Extension, Distractor) as within-subjects factors, and; the dependent measure was the number of responses produced at test. The analysis revealed a main effect of Response Type, $F(1, 39) = 86.85, p < .001$, a main effect of Event Type, $F(1, 39) = 5.68, p < .03$, and a significant Event Type by Response Type interaction, $F(1, 39) = 20.63, p < .001$; there was no main effect or interaction with Condition.

Post-hoc tests with Sidak corrections revealed that there was a significant difference in children’s extension responses across the two event types ($p = .001$) and there was a trend towards significance for distractor responses ($p < .06$). Within each event type, there was a significant difference between the two types of responses children made (see Fig. 8).

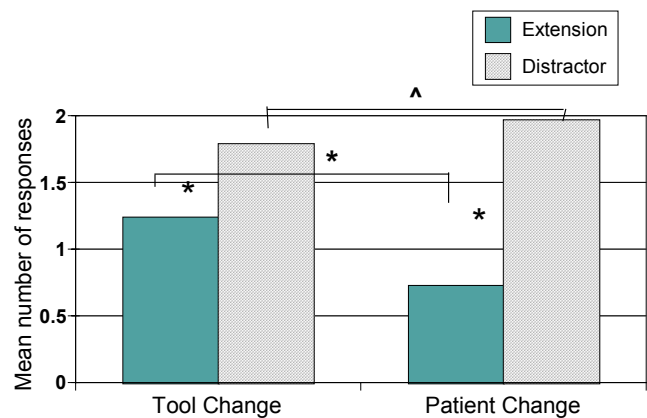


Fig. 8: Study 3 Results.

Discussion

This study provides clear evidence showing that particular object changes—i.e., tool changes—influenced children’s enactments. Events in which the patient changed did not appear to lead to appropriate verb extensions in the same way. Naming the objects that were changing appeared to have no influence as there was no main effect or interaction with our different sentence conditions. Thus, children did not appear to use the nouns in sentences to direct their attention to tools or to patients. One reason for this result may be that comparing events requires so many cognitive resources that there are few left over to use to process the linguistic information. Given that this study was the first to try to examine both structural alignment and linguistic information in verb learning, further studies examining the interaction of these cues are needed. Children in real world settings would have access to both of these cues and likely

do use both types of information, though our study suggests they may not use both types of cues simultaneously.

General Discussion

Three studies provide preliminary evidence of children's use of structural alignment in learning new verbs. Further studies are needed to explore specific aspects of each of these studies. However, there is no other theory of verb learning which would predict these patterns of results across these studies. Most studies of new verb learning in young children present the child with only a single new example of an event that corresponds to the new verb. Yet, children have access to multiple events in their everyday life. If children can make use of the information available across these events, perhaps by aligning them based on their relational structure, they could use the information about similarities and differences across events to refine their understanding of the appropriate situational contexts to which a new verb refers. Our lab is the first to try to adapt Gentner's theory to early verb learning, and the results are promising (see also Childers & Paik, 2008, for a cross-cultural study). This view leads to important predictions to address, and may describe a core mechanism children may use to learn new verbs.

Acknowledgments

Funding was provided by a grant from the National Institutes of Health (1R15 HD044447-01) and by Trinity University.

References

- Behrend, D. (1995). Processes involved in the initial mapping of verb meanings. In M. Tomasello & W. E. Merriman (Ed.s), *Beyond names for things: Young children's acquisition of verbs*. Hillsdale, NJ: Lawrence Erlbaum Associates.
- Childers, J. B. & Paik, J. H. (in press). Korean- and English-speaking Children Use Cross-situational Information to Learn Novel Predicate Terms. *Journal of Child Language*.
- Fenson, L., Dale, P., Reznick, J. S., Bates, E., Thal, D., & Pethick, S. J. (1994). Variability in early communicative development. *Monographs of the Society for Research in Child Development*, 59, v-173.
- Forbes, J. N. & Farrar, M. J. (1995). Learning to represent word meaning: What initial training events reveal about children's developing action verb concepts. *Cognitive Development*, 10, 1-20.
- Gentner, D. (1983). Structure-mapping: A theoretical framework for analogy. *Cognitive Science*, 7, 155-170.
- Gentner, D. (1989). The mechanisms of analogical learning. In S. Vosniadou & A. Ortony (Eds.), *Similarity and analogical reasoning*. New York: Cambridge University Press.
- Gentner, D. & Markman, A. (1997). Structure mapping in analogy and similarity. *American Psychologist*, 52, 1, 45-56.
- Gentner, D., & Namy, L. (2000). Comparison in the development of categories. *Cognitive Development*, 14, 487-513.
- Gleitman, L., & Gleitman, H. (1992). A picture is worth a thousand words, but that's the problem: The role of syntax in vocabulary acquisition. *Current Directions in Psychological Science*, 1, 31-35.
- Gropen, J., Pinker, S., Hollander, M., & Goldberg, R. (1991). Affectedness and direct objects: The role of lexical semantics in the acquisition of verb argument structure. *Cognition*, 41, 153-95.
- Loewenstein, J. & Gentner, D. (2001). Spatial mapping in preschoolers: Close comparisons facilitate far mappings. *Journal of Cognition and Development*, 2, 189-219.
- Markman, A. & Gentner, D. (1993). Structural alignment during similarity comparisons. *Cognitive Psychology*, 25, 431-467.
- Meltzoff, A. N. (1995). Understanding the intentions of others: Re-enactment of intended acts by 18-month-old children. *Developmental Psychology*, 31, 838-50.
- Paik, J. H. & Mix, K. S. (2006). Preschooler's use of surface similarity in object comparisons: Taking context into account. *Journal of Experimental Child Psychology*, 95, 194-214.
- Sidak, Z. (1967). Rectangular confidence regions for the means of multivariate normal distributions. *Journal of the American Statistical Association*, 62, 626-33.
- Slobin, D. I. (1981). The origins of grammatical encoding of events. In W. Deutsch (Ed.) *The child's construction of language*. New York: Academic Press.
- Talmy, L. (1975). Semantics and syntax of motion. In J. P. Kimball (ed), *Syntax and Semantics: Volume 4*. New York: Academic Press.
- Tomasello, M. (1992). *First verbs: A case study of early grammatical development*. New York, New York: Cambridge University Press.
- Waxman, S. R., & Klibanoff, R. S. (2000). The role of comparison in the extension of novel adjectives. *Developmental Psychology*, 36, 571-581.