Structural Alignment in Incidental Word Learning

Ruxue Shao (ruxueshao2018@u.northwestern.edu)
Dedre Gentner (genter@northwestern.edu)

2029 Sheridan Road, Evanston, IL, 60208, USA

Abstract

Young children can sometimes acquire new vocabulary words with only limited, indirect exposure (Carey & Bartlett, 1978). We propose that structural alignment processes lead to fluent detection of commonalities and differences that facilitate incidental word learning. To test this, we adapted the Carey and Bartlett paradigm, varying the alignability of the objects that 4-year-olds saw while hearing the novel word *chromium*. In Experiment 1, children in the High-Alignment condition were significantly better than those in the Low-Alignment condition at identifying chromium objects in a subsequent task. In Experiment 2, we ruled out an alternative account by equalizing the overall amount of information presented to the two groups. We also found that the advantage of high alignment persisted after two-to-four days. These results suggest that structural alignment is a mechanism by which children can learn word meanings even in incidental word learning situations.

Keywords: incidental word learning; structural alignment; alignable differences

Introduction

Children acquire vocabulary words in many ways. Sometimes, a helpful adult points to an object of interest and gives a clear label for it. For example, the teacher might point to a rubber duck and tell the child "Look, a duck!" Yet these instances of explicit word learning are far from the whole picture. Children also learn many words spontaneously through daily conversation, media consumption, joint reading, and so on (e.g. Akhtar, Jipson, & Callanan, 2001; Krcmar, Grela, & Lin, 2007; Senechal & Cornell, 1993).

Carey and Bartlett (1978) conducted a classic study on young children's incidental word learning. They exposed 3.5-year-olds to a new color term (*chromium*) for an unfamiliar color (dark olive green). Children saw two trays that were identical on every dimension except color (see Figure 1), and were asked to "Give me the chromium one, not the red one." Even with such limited input, approximately half of the children were able to demonstrate some knowledge of the word *chromium* at a later time.

Carey and Bartlett's findings have inspired many researchers to further investigate this question from multiple perspectives (e.g. Bion, Borovsky, & Fernald, 2013; Golinkoff, Hirsh-Pasek, Bailey, & Wenger, 1992; Heibeck & Markman, 1987; Wagner, Dobkins, & Barner, 2013). Our interest here is in what processes enabled children to learn a new word from such minimal, indirect exposure. We propose structural mapping as a mechanism that can lead to rapid spontaneous learning.

According to Structure Mapping Theory, comparison involves a process of *structural alignment* between two representations (Gentner, 1983, 2010). This process not only reveals commonalities, but also highlights *alignable differences*—differences that play the same role in the shared structure. Alignable differences emerge easily and quickly when comparing items that are high on overall similarity (Sagi, Gentner, & Lovett, 2012). Both children and adults find it easier to generate differences for high-similarity object pairs than for low-similarity ones (e.g. Gelman, Raman, Gentner, 2009; Gentner & Gunn, 2001; Markman & Gentner, 1994). Thus, for high-similarity pairs, alignable differences emerge quickly and spontaneously.

From this perspective, the Carey and Bartlett (1978) findings can be interpreted as follows. Children were asked to 'give me the chromium one, not the red one," and their goal (we assume) was simply to comply with this request (which they may have interpreted simply as "give me the one that's not red"). However, when they saw two highly similar trays, a spontaneous alignment process took place, and the alignable difference between the two trays (their color) popped out. Thus, even without overt effort to learn a new word, the children may have associated this newly highlighted color with the new word, *chromium*.

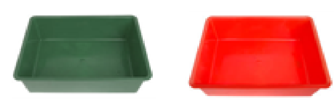

Figure 1: Trays shown in the Carey and Bartlett (1978) study

To test this claim, we adopted a paradigm similar to the one used by Carey and Bartlett (1978), but varied the similarity (and thus the alignability) of the objects pairs presented. The question is whether children will learn the meaning of the term *chromium* from indirect exposure, and whether alignability will be a determining factor.

Experiment 1

We presented children with a pair of objects that were either high in alignment (HA) or low in alignment (LA). Children were asked to "point to the chromium one—the chromium one, not the blue one." After a short delay, we assessed whether they could identify chromium objects in a yes-no task. We predicted that children in the HA condition would show better understanding of the word *chromium* than those in the LA condition.

Methods

Participants Sixty-three 4-year-olds (mean age=54.05 months, SD= 3.28 months, range= 48-59 months) participated in the study. Among them, thirty-two 4-year-olds were assigned to the High-Alignment (HA) condition and the remaining to the Low-Alignment (LA) condition. An additional five children were tested but excluded, one due to showing a yes bias, one for failing to complete the experiment, and three due to experimenter error. All children were recruited from the greater Chicago area through a voluntary participant pool or from local preschools.

Initial Exposure As a warm-up, children first received two simple two-alternative-forced-choice trials (e.g. “point to the cow, not the lion”). Then they received the key Initial Exposure trial. Children in the HA group saw two highly similar (readily alignable) objects (as in the Carey and Bartlett study), while those in the LA group saw a less alignable pair (Figure 2). All figures were made from foam and were approximately the same size. Both groups were asked, “Look at these two! Can you point to the chromium one? The chromium one, not the blue one.” Importantly, all children (in both the HA and LA groups) were able to correctly pick out the chromium object during the initial exposure.

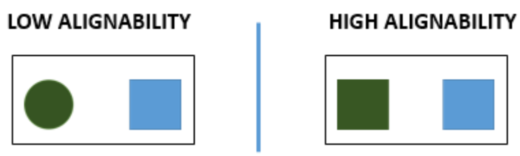

Figure 2: Experiment 1 Initial Exposure objects.

Meaning Assessment Approximately 10 minutes after the initial exposure, children were assessed on whether they had learned the meaning of *chromium*. They were shown eight geometric figures, each with a unique combination of color and shape. Among the figures, three were chromium and five were of other colors (See Figure 3). For each group, there was one previously-seen chromium figure and two new ones. (Children in the HA group had seen the chromium square, while those in the LA group had seen the chromium circle.) In addition, all children had seen the blue square in the Initial Exposure trial and the maroon triangle during the warm-up trials.

Children were shown the objects one at a time, and asked, “Look at this one! Is this a chromium one?” Based on the child’s answer, the object was placed in either a Yes Box or a No Box. If the child failed to answer, or indicated that (s)he did not know, the experimenter repeated the question. No participant required more than three requests to answer a question.

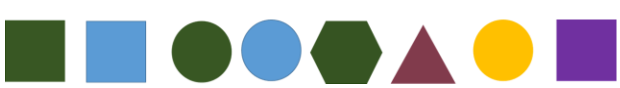

Figure 3: Experiment 1Meaning Assessment objects

Results

In the Initial Exposure phase, all children were able to correctly pick out the chromium object on the first attempt. However, as predicted, significant differences were found between the HA and LA groups in the Meaning Assessment task. The HA group was able to correctly identify more chromium objects (more hits) than the LA group ($M_{LA} = 1.77$, $M_{HA}= 2.50$, max =3.0; $t(61) = 8.81$, $p = .004$, one-tailed t test). There was no difference in the number of false alarms (identifying non-chromium objects as *chromium*) made by the two groups ($M_{LA} = 1.23$, $M_{HA} = 1.77$, max=5.0; $t(61) = 2.78$, *n.s.* one-tailed t test). Thus the difference in hit rate was not due to an overall inclination of the HA group to respond more positively.

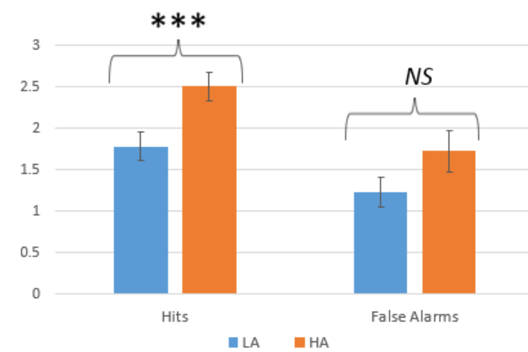

Figure 4: Mean number of hits (max = 3) and false alarms (max = 5) made by the LA and HA groups in Experiment 1.

We also found a difference between the two groups when comparing their performance to chance. Children in the HA condition scored significantly better than chance (1.5) at identifying chromium objects ($t(31)=7.42$, $p<.001$). However, performance in the LA group did not differ from chance ($t(30)=1.33$, *n.s.* one-tailed t test).

Our hypothesis is that for the HA group, a spontaneous, non-deliberate alignment process resulted in children’s noticing the alignable difference in color. However, it is also possible that the difference between the two groups lay in differential forgetting. Perhaps children in the LA group had more difficulty remembering the initial chromium object. To test this possibility, we statistically controlled whether children were able to successfully identify the Initial Exposure object as *chromium* during the Meaning Assessment task. When we compared performance on the other objects in the Meaning Assessment Task, we found the same pattern as before, indicating that the performance gap in the Meaning Assessment task cannot be attributed to differential item memory for the initial item.

Discussion

Children in the HA condition were significantly more likely than those in the LA condition to discern the meaning of the word *chromium*. Although both groups were able to “point to the chromium one, not the blue one” when shown the two initial objects side by side, only the HA group showed evidence of being able to differentiate *chromium* objects from non-*chromium* ones in a subsequent task. These findings are consistent with our predictions based on the structural alignment account.

We believe that the HA group was able to "pick up" the word *chromium* without a deliberate intention to learn a new word. For children in the HA condition, the chromium color was highlighted during the Initial Exposure when it emerged as an alignable difference from the familiar color, blue. This provided participants with a perceptual sensation that could attach to the new word. In other words, we suggest that high-alignment comparison essentially made the mapping of *chromium* to the color 'dark olive green' effortless.

However, before embracing this account, we need to assess an alternative possibility. Children may have been actively trying to learning the meaning of the novel word. In this case, the overall amount of information available to them becomes very important. For the HA group, the two objects shown during the Initial Exposure differed in only one dimension – color. In contrast, the LA group saw objects that differed in both color *and* shape. From a hypothesis-testing point of view, the LA children had to consider two possible hypotheses for the meaning of *chromium*—a color hypothesis (dark olive green) and a shape hypothesis (round). In contrast, the HA children only had to consider one hypothesis: that *chromium* refers to dark olive green. Thus, the advantage shown by the HA group over the LA group could have resulted from the differential amount of information available to the two groups, rather than from the greater ease of alignment.

Experiment 2 was designed to distinguish between these two accounts. We again created two groups—HA and LA—but gave children in both groups two trials, to equate the amount of information they received. In addition, we wanted to assess the strength of the word-meaning link formed here. In Experiment 1, children were tested on the meaning of *chromium* 10 minutes after the Initial Exposure, with a collection of geometric shapes similar to those used in the Initial Exposure. In Experiment 2, we asked whether we would still find evidence of learning if the delay was longer and the set was larger. In the same spirit, we also asked whether children would be able to transfer their learning to a very different set of items.

Experiment 2

The goals of Experiment 2 were (1) to assess the effects of alignability in incidental learning while equating the overall amount of information given; and (2) to explore the robustness of the learning effect. To equate the information given to the two groups, we provided both the HA and LA groups with two exposure trials during the Initial Exposure., such that both groups could logically rule out shape as the meaning of *chromium* and settle on color. We then assessed children's knowledge of the word *chromium* on the day of the exposure (Day 1), and also two-to-four days later (Day 2). Day 2 featured both a retention task and a transfer task.

Participants

Forty 4-year-olds (*M*=53.63 months, SD= 3.56 months, range= 48-59 months) participated in Experiment 2. Nineteen of them were placed in the High-Alignment (HA) condition and twenty-one in the Low-Alignment (LA) condition. Children were recruited through the same methods used in Experiment 1.

Day 1

Materials and Procedure The procedure for Day 1 was highly similar to that of Experiment 1. Children received a warmup trial, and then encountered the word *chromium* and its referent color. However, instead of just one exposure, they were given two chances to form the mapping between word and color, as described below. They then took a short break, and afterwards revisited the word and color in a sorting task.

On each of the Initial Exposure trials, children saw a blue object and a chromium object side by side. The experimenter asked, "Can you point to the chromium one? The chromium one, not the blue one." The Initial Exposure trials were not presented consecutively—a foil trial (similar to the warmup trial) separated the two.

The trials were designed to permit the LA group to rule out the shape hypothesis, leaving them with only the color hypothesis— and thus removing the informational advantage of the HA group. On Initial Exposure Trial 1, the LA group saw two objects differing in color and shape, leaving two possible hypotheses for the meaning of *chromium*:

(1) *chromium* = dark olive green color
(2) *chromium* = cross shape

One Trial 2, the LA group saw two new objects. Crucially, the 'chromium' object (the non-blue object) was now a different shape (an upside-down triangle) but retained the same color. Thus, children in the LA condition could rule out the shape hypothesis and arrive at the correct meaning.

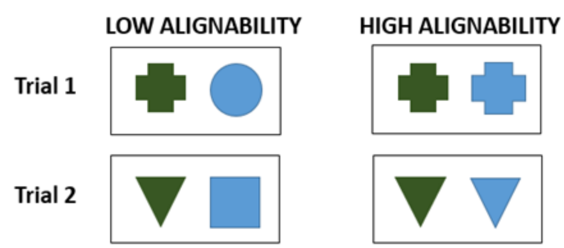

Figure 5: Experiment 2, Day 1: Initial Exposure Objects

Children in the HA condition also received two trials, designed so that the chromium objects were the same as those seen by the LA group. However, to facilitate structural alignment, these objects were paired with another object of the same shape within each trial. The HA group saw a chromium square and a blue square on one trial, and a chromium circle and a blue circle on the other. As in Experiment 1, the objects were identical on every dimension except for color. Figure 4 shows the Initial Exposure for Experiment 2, Day 1.

A new and extended set of 14 geometric shapes was used in this experiment for the Meaning Assessment task (Figure 6). There were five chromium objects—including two that had been previously seen by both groups—and nine non-chromium objects. The procedures for the Meaning Assessment Task in Experiment 2 Day 1were exactly the same as those for Experiment 1.

Figure 6: Experiment 2: Figures Used in Meaning Assessment (Day 1) and Retention Task (Day 2)

Results As in Experiment 1, all children in the HA and LA groups were able to correctly pick out the chromium object during the Initial Exposure.

In the Meaning Assessment task, children in the HA group were able to correctly identify more chromium objects (more hits) than those in the LA group (M_{LA}= 3.71, M_{HA}= 4.63, max = 5.0; t (38)= 2.18, p=.020, one-tailed t test). Also similar to Experiment 1, there was no difference in the number of false alarms made (M_{LA}= 1.76, M_{HA}= 1.32, max = 9.0; t(38)=0.70, *n.s.*, one-tailed t test).

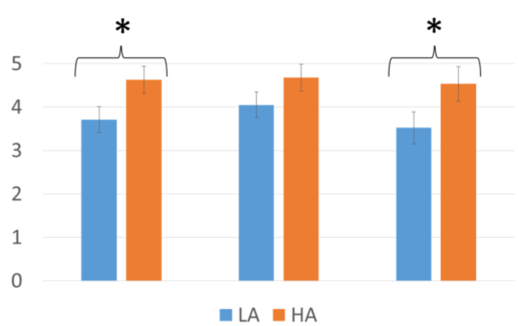

Figure 7: Experiment 2: Mean number of hits (max=9) on Day 1 Meaning Assessment task, Day 2 Retention Task, and Day 2 Transfer Task.

Day 2: Retention and Transfer

Materials and Procedure After two to four days (M= 2.45, SD= 0.75), children returned to the lab for Day 2 of the experiment. Children in the HA and LA groups went through the same procedure: a Retention Task, a Reminder, and a Transfer Task.

The goal of the Retention Task was to assess how well children retained whatever meaning they had assigned to *chromium* on Day 1. Thus, the Retention Task was an exact duplicate of the Meaning Assessment task on Day 1. After the Retention Task, children were presented with a Reminder similar to the Initial Exposure on Day 1. All children saw the same two cards side by side, one depicting a blue fish and the other a chromium fish. The experimenter asked, “Look at these two! Can you point to the chromium one? The chromium one, not the blue one!” All children were successful on this task. After the Reminder, children engaged in the Transfer Task. The Transfer Task used the same format as Day 1’s Meaning Assessment task, except that all of the objects being sorted were picture cards of different colored and shaped fish. The fish cards consisted of 14 line drawings of fish. Similar to the set shown in Figure 6, five of the fish were chromium, four were blue, and the rest were of various colors.

Results Although the Retention task’s pattern of results suggested that the HA group made more hits than the LA group, the difference between the two groups did not reach significance (see Figure 7). There was no difference between the two groups in the number of false alarms.

When provided with a Reminder exposure to the word *chromium* and the color dark olive green, all children were able to pick out the correct chromium object on the first attempt, consistent with the pattern in the Initial Exposure task in both Experiment 1 and Experiment 2 Day 1.

In the Transfer Task, the HA group again showed an advantage over the LA group: they identified a significantly higher number of dark olive green fish as *chromium* than the LA group (M_{LA}= 3.52, M_{HA}= 4.53, max= 5.0; t(38)=1.84, p=0.037, one-tailed t test). The number of false alarms made by the two groups did not differ, once again mirroring previous results.

Discussion

The findings of Experiment 2 replicated and extended those of Experiment 1. On Day 1, children in both the HA group and LA group received sufficient information to rule out shape and settle on color as the meaning of chromium. Yet we found the same performance pattern as in Experiment 1: although all children were able to correctly pick out the chromium object in the Initial Exposure, the HA group did significantly better than the LA group on a subsequent Meaning Assessment task. These results argue against a difference in information as the explanation for the HA group’s advantage. Instead, the greater fluency of structural alignment seems to be the key distinguishing factor here.

On Day 2, children were assessed on the meaning of the word *chromium* using the same objects that they had seen on Day 1 (the Retention Task). Although we did not find significant HA advantage in the Day 2 Retention task, the HA group went on to significantly outperform the LA group in the Transfer task: Children in the HA group demonstrated better understanding of the word *chromium* than those in LA group on the new items shown in the Transfer Task.

General Discussion

The current studies provide evidence supporting the hypothesis that spontaneous structural alignment promotes incidental word learning. In Experiment 1, we manipulated the alignability of the objects that children saw during the Initial Exposure. Although all children in both groups readily picked out ‘the chromium one, not the blue one’, the two groups differed dramatically in how much they learned from this experience. Children in the HA condition were able to differentiate between chromium objects and non-chromium objects in a subsequent task, while those in the LA condition performed at chance. In Experiment 2, we equalized the amount of information presented to the two groups during the Initial Exposure and still found an advantage of the HA group over the LA group. This advantage persisted two to four days after the Initial Exposure, as evidenced in the Transfer Task—the HA group (but not the LA group) was able to transfer their understanding to a very different set of objects.

We suggest that the high overall similarity between the initially shown objects benefitted the HA group in two ways. First, it invited spontaneous comparison, initiating a structural alignment process. Second, the high alignability of the two objects made structural alignment fast and essentially effortless, so the alignable difference of color “popped out” and was easily detected. Structural alignment allowed children to quickly and easily “pick up” a perceptual placeholder for the new word *chromium*, even without any conscious intentions of decrypting it.

We suggest that in this task, children were simply engaging in a social interaction with the experimenter, and their goal was to comply with the experimenter’s request. Nevertheless, given the fortunate learning situation presented to the HA group, they were able to learn the meaning of a new word *chromium* without any prior intention of doing so.

For the LA group, who saw objects that were dissimilar, structural alignment did not spontaneously occur. Thus, although they were able to correctly pick out the chromium object when given the verbal contrast “the chromium one, not the blue one,” there was no evidence that they formed a link between the novel word *chromium* and its corresponding property.

Of course, we note that either group could have focused on the color hypothesis for linguistic reasons. The syntax of the request-- ‘the chromium one, not the blue one”—would have allowed an adult to infer that the key dimension of difference was probably color. However, it’s not clear that 4-year-olds understand this convention. Indeed, the poor performance of the LA group suggests that they did not benefit from such an insight. We aim to shed light on this issue in further research

These results are consistent with prior work showing that structural alignment processes support children’s learning (Childers & Paik, 2009; Ferry, Hespos, & Gentner, 2015; Gentner, Anggoro & Klibanoff, 2011; Waxman & Klibanoff, 2000). Explicit instructions to compare exemplars can promote learning in both adults as well as children (Catrambone & Holyoak, 1989; Gick & Holyoak, 1983; Loewenstein et al., 1999; Markman & Gentner, 1993). Evidence for such effects has been found across perceptual and conceptual domains, including spatial configurations (Christie & Gentner, 2010), mathematics (Richland, Zur, & Holyaok, 2007; Richland, Holyoak, & Stigler. 2004; Rittle-Johnson & Star, 2007; Thompson & Opfer, 2010), word learning (e.g., Graham et al., 2010), part-learning (Gentner, Loewenstein, & Hung, 2007), and science education (Jee et al., 2010; Kurtz & Gentner, 2013). However, to the best of our knowledge, this is the first study that examines the role of structural alignment in incidental learning situations.

Incidental learning experiences are clearly an important part of children’s language learning, yet they are almost invisible in nature. Such experiences can occur at different times and places, with no necessary pedagogical intention on the part of the adult, nor any intention to learn on the part of the child. They depend on the learner noticing the new information for himself or herself. The current studies show that structure mapping is a powerful mechanism for incidental learning. When the target information is highlighted as an alignable difference, it is more likely that spontaneous learning will take place.

Acknowledgments

We thank the children, families, and preschools that participated in the study, Emma Bulzoni and Katherine Cha for their help in conducting the experiments, and members of the Project on Children’s Thinking for their insightful suggestions. This work was supported by NSF SLC Grant SBE-0541957 awarded to the Spatial Intelligence and Learning Center (SILC), and by ONR Grant N00014-13-1-0470 to Dedre Gentner.

References

Akhtar, N., Jipson, J., & Callanan, M. A. (2001). Learning words through overhearing. *Child Development, 72*(2), 416-430.

Bion, R. A., Borovsky, A., & Fernald, A. (2013). Fast mapping, slow learning: Disambiguation of novel word–object mappings in relation to vocabulary learning at 18, 24, and 30 months. *Cognition, 126*(1), 39-53.

Carey, S., & Bartlett, E. (1978). Acquiring a single new word. *Proceedings of the Stanford Child Language Conference, 15*, 17-29.

Childers, J. B., & Paik, J. H. (2009). Korean-and English-speaking children use cross-situational information to learn novel predicate terms. *Journal of Child Language*, *36*(1), 201-224.

Christie, S., & Gentner, D. (2010). Where hypotheses come from: Learning new relations by structural alignment. *Journal of Cognition and Development, 11*(3), 356-373.

Ferry, A. L., Hespos, S. J., & Gentner, D. (2015). Prelinguistic relational concepts: Investigating analogical processing in infants. *Child Development,86*(5), 1386-1405.

Gelman, S., Raman, L., & Gentner, D. (2009). Effects of language and similarity on comparison processing. Language Learning and Development, 5, 147-171.

Gentner, D., & Boroditsky, L. (200

Gentner, D. (1983). Structure-Mapping: A Theoretical Framework for Analogy. *Cognitive Science*, *7*(2), 155-170.

Gentner, D. (2010). Bootstrapping the mind: Analogical processes and symbol systems. *Cognitive Science*, *34*(5), 752-775.

Gentner, D., Anggoro, F. K., & Klibanoff, R. S. (2011). Structure-mapping and relational language support children's learning of relational categories. *Child Development, 82*(4). 1173-1188.

Gentner, D., & Gunn, V. (2001). Structural alignment facilitates the noticing of differences. *Memory and Cognition*, *29*(4), 565-577.

Gentner, D., Loewenstein, J., & Hung, B. (2007). Comparison facilitates children's learning of names for parts. *Journal of Cognition and Development, 8*(3), 285-307.

Gentner, D., & Kurtz, K. J. (2006). Relations, objects, and the composition of analogies. *Cognitive Science, 30*(4), 609-642.

Gentner, D., & Markman, A. B. (1994). Structural alignment in comparison: No difference without similarity. *Psychological Science*, *5*(3), 152-158.

Gentner, D., & Markman, A. B. (1997). Structure mapping in analogy and similarity. *American Psychologist*, *52*(1), 45.

Gentner, D., & Medina, J. (1998). Similarity and the development of rules. *Cognition, 65*(2), 263-297

Gentner, D., & Namy, L. L. (1999). Comparison in the development of categories. *Cognitive Development, 14*(4), 487-513.

Gick, M. L., & Holyoak, K. J. (1983). Schema induction and analogical transfer. *Cognitive Psychology*, *15*(1), 1-38.

Golinkoff, R. M., Hirsh-Pasek, K., Bailey, L. M., & Wenger, N. R. (1992). Young children and adults use lexical principles to learn new nouns. *Developmental Psychology, 28*(1), 99

Graham, S., A., Namy, L. L., Gentner, D., & Meagher, K. (2010). The role of comparison in preschoolers' novel object categorization. *Journal of Experimental Child Psychology, 107*. 280-290.

Heibeck, T. H., & Markman, E. M. (1987). Word learning in children: An examination of fast mapping. *Child Development,* 1021-1034.

Jee, B. D., Uttal, D. H., Gentner, D., Manduca, C., Shipley, T., Sageman, B., Ormand, C. J., & Tikoff, B. (2010). Analogical thinking in geoscience education. *Journal of Geoscience Education, 58* (1), 2-13A

Krcmar, M., Grela, B., & Lin, K. (2007). Can toddlers learn vocabulary from television? An experimental approach. *Media Psychology*, *10*(1), 41-63.

Kurtz, K. J., & Gentner, D. (2013). Detecting anomalous features in complex stimuli: the role of structured comparison. *Journal of Experimental Psychology: Applied*, *19*(3), 219.

Loewenstein, J., Thompson, L., & Gentner, D. (1999). Analogical encoding facilitates knowledge transfer in negotiation. *Psychonomic Bulletin & Review, 6,* 586-597.

Markman, A. B., & Gentner, D. (1993). Structural alignment during similarity comparisons. *Cognitive Psychology, 25*(4), 431-467.

Richland, L. E., Holyoak, K. J., & Stigler, J. W. (2004). Analogy use in eighth-grade mathematics classrooms. *Cognitiion and Instruction, 22*, 37-60.

Richland, L. E., Zur, O., & Holyoak, K. J. (2007). Cognitive supports for analogies in the mathematics classroom. *Science, 316*, 1128-1129.

Rittle-Johnson, B., & Star, J. R. (2007). Does comparing solution methods facilitate conceptual and procedural knowledge? An experimental study on learning to solve equations. *Journal of Educational Psychology*, *99,* 561–574.

Sagi, E., Gentner, D., & Lovett, A. (2012). What difference reveals about similarity. *Cognitive Science, 36*(6), 1019-1050.

Senechal, M., & Cornell, E. H. (1993). Vocabulary acquisition through shared reading experiences. *Reading Research Quarterly*, 360-374.

Thompson, C. A., & Opfer, J. E. (2010). How 15 hundred is like 15 cherries: Effect of progressive alignment on representational changes in numerical cognition. *Child Development, 81*(6), 1768-1786.

Wagner, K., Dobkins, K., & Barner, D. (2013). Slow mapping: color word learning as a gradual inductive process. *Cognition, 127*(3), 307-317.

Waxman, S. R., & Klibanoff, R. S. (2000). The role of comparison in the extension of novel adjectives. *Developmental Psychology, 36*(5), 571.