Title

Children’s Representations of Five Spatial Terms

Journal
Proceedings of the Annual Meeting of the Cognitive Science Society, 40(0)

Authors
Weber, Jennifer M
Miller, Hilary E
Ou, Lu

Publication Date
2018

Children's Representations of Five Spatial Terms

Jennifer M. Weber (jennifer.m.ellis@colorado.edu) [1,2]
[1] Department of Psychology and Neuroscience, Muenzinger D244, 345 UCB, Boulder, CO 80309- USA

Hilary E. Miller (hemiller@wics.edu) [2]
[2]Department of Psychology, 1202 W. Johnson Street, Madison, WI 53706 USA

Lu Ou (lu.ou@act.org) [3]
Vanessa R. Simmering (vanessa.simmering@act.org) [2,3]
[3]ACTNext by ACT, Inc. 500 ACT Drive, Iowa City, IA

Abstract

This study is an exploratory analysis of young children's representation of five spatial terms: *above, under, by, next to,* and *between.* Children (n = 76) and adults (n = 11) indicated the spatial extent of a grid they thought each term indicated. Qualitative analyses were used to categorize responses, separately for each word, and showed more agreement among adults than children. Furthermore, children who showed adult-like representations were generally older than those who showed unsystematic responses. Quantitative analyses, using a median split in age to create two groups of children, compared representational sizes and distances from the referent(s). For *above, under,* and *between*, adults had larger representations than children; the trend was reversed but not significant for *by* and *next to*. Furthermore, representation size was correlated for *above* and *under*, but not for *by* and *next to*. Analyses of distances showed a predicted reversal in the vertical dimension of *above* and *under* that interacted with age. There were no differences across age groups or terms for *by* and *next to*, but *between* showed a decrease in horizontal distance over development. These results suggest that children may initially understand words differently than adults do.

Keywords: spatial language; cognitive development; representation

Spatial Word Learning

What does it mean to know a word? This question that long been a center of debate in word learning (e.g., Perry & Saffran, 2017), and here we consider it specifically for spatial words in English. Spatial words provide an interesting case because they vary cross-linguistically in ways that influence perceptual categorization (e.g., tight- versus loose-fit in Korean; Choi & McDonough, 2007). Many English spatial words are polysemous, with meanings that range in abstractness by context (e.g., "*on* a table", "*on* task", "*on* time"), which could affect the learning trajectory over development (Verspoor & Lowie, 2003). Additionally, some spatial terms describe similar relations but require attention to relatively subtle distinctions (e.g., *by* versus *between*) to correctly interpret or produce such terms.

The goal of the current study is to conduct an exploratory analysis of young children's representations of five spatial terms. The literature on spatial word learning is relatively small, with much more research devoted to broader categories of words like nouns and verbs, leaving open many questions about how children represent spatial words as they learn them. Our question here focus on how similar young children's representations of these spatial terms are to each other's, and to adults' representations.

As children learn words, they commonly make two types of errors: over-extensions, in which they apply a word to instances outside of the category (e.g., calling most four-legged animals *dog* or all round objects *ball*) or under-extensions, in which they fail to apply the word to instances within the category (e.g., calling golden retrievers *dog* but not chihuahuas, calling basketballs *ball* but not soccer balls). These phenomena have mostly been described in the acquisition of nouns and verbs, but can also be found with other terms including spatial words (e.g., Clark, 1973). It is unclear whether such errors in children's use of spatial terms arise through errors in the production process, or if they reflect the representations that underlie the spatial terms.

Determining the proper spatial term to use depends on multiple factors, most of which tax spatial cognition. For example, 4-year-old children have trouble identifying *left* and *right* on a doll, but do so easily on their own bodies. This trouble did not extend to the front and back sides (Li, Shusterman, & McNaughton, 2018). This suggests that some spatial concepts might be easier to map to words than others because children can reason about them more fluently even in non-linguistic contexts. Also, children's understanding of the relative nature of *by* increased with their ability to remember the objects' locations (Hund & Naroleski, 2008), suggesting a parallel between spatial representations and spatial word learning.

Overlap in spatial term boundaries also plays an important role in children's learning. For example, the relation *middle* could also be described as *between*, but the reverse is not always true (i.e., some *between* relations are not *middle*). In typical learning instances, the nature of this differentiation is likely not made explicit, but must be inferred across many experiences with each term. Foster and Hund (2012) studied young children's acquisition of these terms and found that children used *between* from an earlier age with increasing frequency, while *middle* had a slower rate of acquisition. Perhaps *middle* was learned more slowly due to its more specific spatial representation, or due to potential conflict with the representation of *between*.

Farran and Atkinson (2016) investigated when children develop adult-like representations of nine spatial terms using an odd-one-out task. They used three levels to describe performance. Level 1 was a rigid understanding, when children only generalize the term if the scene uses the same referents and target objects. Level 2 was more abstract, when children generalized to different objects but only understood prototypical representations. Level 3 incorporated both prototypical and non-prototypical examples (e.g., *above* with the target offset from the vertical axis). They found that even at 7 years of age, most children had not reached Level 3 understandings of terms like *left* and *right*. At age 4, children had not developed any Level 3 representations of the nine terms tested. *In*, *on* and *under* appeared to develop earlier than *behind*, *above* and *below*, with *left* and *right* showing the latest development. Comprehension and production tasks showed that increases in spatial term production were associated with increased understanding with age.

In summary, children's understanding of spatial terms undergoes protracted development during early childhood, but relatively few investigations have systematically compared representations of multiple terms over development. The goal of the current study was to conduct an exploratory analysis of children's representation of spatial terms using an open-ended task design.

Current Study

We designed a task in which children indicated the extent in space that corresponds to a target term. This design is a hybrid between comprehension and production tasks because it requires children to comprehend the word and produce the representation. We then compared children's representations across age, and to adults' representations, to determine whether there are systematic developmental changes.

We had two general predictions for this study. First, we expected less variance in adults' representations (i.e., more similarity across participants) than children's, due to their additional experience hearing and producing these words. It is possible that we will see an age-related reduction in variance within the child age group, but not enough is known about the learning trajectories of these terms to ensure that this change would occur within the age range we sampled. One goal of this study is to begin to establish the timing of learning for these terms.

Second, we hypothesized that the size of representations could change over development. In parallel to over- and under-extensions in young children's learning of nouns and verbs, we might see narrowing or broadening (respectively) of representations over development, either during childhood or from children to adults. Although this prediction follows from the broader word learning literature, it is not known if all types of words show one of these patterns. Rather, it is possible that for spatial terms children show no systematic representation of these terms (e.g., some children over-extend, some under-extend) until they are well known.

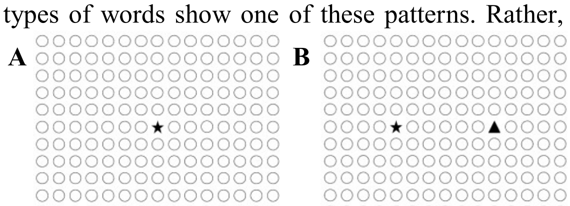

Figure 1. Grids used as stimuli in the task

Method

Participants

Seventy-seven 3- to 6-year-old children (age range: 3.06 – 6.48 years, median = 4.13, *SD* = 0.78; 42 girls) and 11 adults (5 women) participated in this study. Additionally, one child and one adult participated but were excluded due to incomplete data. We divided the child sample into two age groups, split at the median, resulting in 39 younger children (*M* age = 3.58, *SD* = 0.27; 23 girls), and 38 older children (*M* age = 4.88 years, *SD* = 0.55; 21 girls). Child participants were primarily recruited and tested within child-care centers (n = 73) or to come into the lab from the surrounding community using an established database (n = 4). Families that visited the lab were given a small thank-you gift (e.g., stuffed toy, book) for participating. Childcare centers were given donations of educational materials (e.g., books, art supplies) as a thank-you. Adults were recruited through the University of Wisconsin-Madison's SONA system within the Psychology Department and received extra course credit in exchange for participating. Parents of child participants and adult participants all gave informed consent before participation. This study was approved by the University of Wisconsin-Madison Education and Social/Behavioral Science Institutional Review Board.

Materials

We chose five spatial terms from a parent spatial vocabulary checklist used in Miller, Vlach, & Simmering (2017); *above*, *between*, *by*, *next to*, and *under*. We chose these terms as ones with varying familiarity within this age group, and to provide some measures of similarity and contrast. Specifically, we chose *above* and *under* as antonyms that most children within our age range would know (73% and 96%, respectively, based on parent report data for children aged 3y10m to 5y2m, combined from Miller & Simmering, 2018; Miller et al., 2017). We chose *by* and *next to* as synonyms that most children would know (78% and 88%, respectively), and because the systematicity in children's ratings of *by* have been shown to change during early childhood (Hund & Naroleski, 2008). Lastly, we chose *between* as a more exploratory term. A prior pilot study in our lab suggested that many 4-year-olds do not produce this word easily, and only 58% of parents in our prior studies indicated that their children produced this word.

Each response was made on an 11 x 15 grid of circles on a half sheet of 8.5" x 11" paper, shown in Figure 1. For *above, by, next to,* and *under*, there was one referent object (star) located in the middle of the grid (Fig.1a). For *between*, there were two referent objects (star and triangle) located equidistant from the edges in the horizontal plane in the middle of the vertical dimension (Fig.1b).

Procedure

Children were tested in this task either as the only task (in childcare settings, n = 37) or following another unrelated task (in some childcare settings and in the laboratory, n = 40). Words were presented one at a time and children were asked to "Show me all the circles that are __ the star" for *above, by, next to,* and *under*; for *between*, the prompt was, "Show me all the circles that are between the star and the triangle". The experimenter then marked which circles the child indicated. We chose to have the experimenter mark the circles because, in pilot testing, children appeared to get off-task if allowed to color the circles themselves. Terms were presented in one of two counter-balanced orders for all participants, with related-meaning words presented non-sequentially.

Adults were tested on more words than children were, but we present only the common words here. The task was presented to adults on multiple sheets of paper with four grids per sheet, and the relevant word printed above the grid. Again, related-meaning words were presented non-sequentially to reduce direct influence or interference. Instructions for adults read "for each grid, color in the circles that would be described by the word" and were presented at the beginning of the task. Adults completed the task on their own after instructions were given unless questions arose.

Results

We conducted both qualitative and quantitative analyses of participants' representations of the five terms. The qualitative analyses gave a broad sense responses, and the quantitative analyses more precisely assessed developmental change.

Qualitative Analyses

As an assessment of the similarity of representations, we categorized adults' and children's responses subjectively by the general size and shape of the representation. Adults' responses were generally quite similar to each other, with more variability in children's responses. Tables 1-3 show the categories established across terms (note that percentages my not sum to 100 due to rounding). To use the same categories across age groups, we included more types of representations within each category for children. The differences in variability are discussed in the following section on Quantitative Analyses.

Antonym Terms: *Above* and *Under*

For the terms *above* and *under*, we found similar categories reflected around the horizontal axis (see Table 1). Most adults fell into a Wide category, in which they colored all or nearly all of the circles on the top or bottom (respectively) half of the grid. The remaining adults primarily fell into a Narrow category, coloring only one or three columns of dots in a vertical line from the referent. Children were more evenly distributed across the four categories, with a tendency for older children to produce more adult-like representations. A notable minority of children indicated the circles surrounding the referent for these two terms, which we categorized as Around. It is unclear whether children who produced this pattern truly believe that representation reflects the word, or if this was adopted as a 'best guess' strategy when the word was unknown. Children who fell into the Other category, meaning their representations were unlike any in the other categories, could similarly be interpreted to not know the meaning of the term (for all terms).

Table 1: Percentage of participants per category for *above* and *under*, with children's mean age per category

Term	Category	Adults (n=11)	Children (n=77)	Child *M* Age
Above	Wide	64	19	4.57
	Narrow	27	27	4.27
	Around	0	26	4.13
	Other	9	27	4.01
Under	Wide	64	31	4.29
	Narrow	36	36	4.47
	Around	0	10	4.24
	Other	0	22	3.69

Synonym Terms: *By* and *Next To*

The terms *by* and *next to* can be used synonymously, but the responses from adults suggest some differentiation of the representations (see Table 2). For *by*, most adults were Around, with one coloring just the two circles to the side (horizontally) of the referent. For *next to*, most were also Around, but more adults indicated only the sides and one adult drew a vertical line on each side of the referent. Children generally followed the same pattern, with the majority indicating around the referent, but two patterns in *by* seemed noteworthy (each indicated by two children): one was a cross from the referent to all four edges, and the other included all circles in the grid. The ages of the children coloring these patterns were, respectively, notably older and younger than children in the other categories.

Table 2: Percentage of participants per category for *by* and *next to*, with children's mean age per category

Term	Category	Adults (n=11)	Children (n=77)	Child *M* Age
By	Around	91	56	4.29
	Sides (hor.)	9	21	4.23
	Cross	0	3	4.82
	All	0	3	3.65
	Other	0	18	3.97
Next to	Around	64	51	4.33
	Sides (hor.)	27	31	4.22
	Sides (vert.)	9	13	3.59
	Other	0	5	4.69

Exploratory Term: *Between*

We expected the greatest variation in children for the term *between* and ended up with the largest number of systematic categories for children's responses (see Table 3). Adults again showed good agreement, with most indicating a single row between the referents (Flat) and a minority indicating all rows between the referents (Tall). The largest percentage of children fell in the same category as the majority of adults (Flat), but only two were categorized as the other adult representation (Tall). A notable minority of children colored around each referent or around and between, and a number of children also colored straight across (between the referents and also extending to the edges of the grid). Almost a third of child participants fell into these three categories, consistent with our expectation that children this age may not have a strong grasp of the meaning of *between*.

Table 3: Percentage of participants in each category for *between*, with children's mean age per category

Term	Category	Adults (n=11)	Children (n=77)	Child *M* Age
Between	Flat	64	43	4.59
	Tall	36	3	4.12
	Around ea.	0	19	4.03
	Around & between	0	4	4.51
	Across	0	9	3.95
	Other	0	22	3.85

Together, the qualitative analyses suggest that adults' representations were more similar to each other's than children's, and older children generally showed more adult-like representations. There were some unexpected differences in responses between synonymous words *by* and *next to*. We next used quantitative analyses to assess whether age differences in representations were statistically robust.

Quantitative Analyses

We conducted quantitative analyses to compare the size of representations and the distance of representations from the referent(s) across terms and age groups.

Representational Size

For the size comparisons, we tabulated the number of colored circles for each participant for each term. Means and standard deviations are shown in Table 4. This table shows there was not a global trend with age; rather, developmental differences depended on the terms.

Table 4: Mean (SD) representation sizes across terms and age groups

Age Group	Above	Under	By	Next to	Between
Younger children	15.51 (27.79)	17.13 (30.46)	16.95 (35.43)	13.44 (27.06)	8.92 (6.08)
Older children	15.50 (18.98)	13.63 (19.03)	12.79 (9.49)	14.50 (24.96)	10.34 (13.43)
Adults	51.27 (33.33)	50.82 (33.77)	8.91 (5.32)	18.00 (24.22)	23.18 (25.23)

For *above* and *under*, children tended to have smaller representations than adults, and all age groups showed similar sized representations across these terms. A two-way ANOVA comparing sizes with Age Group (younger children, older children, adults) as a between-subjects factor and Term (*above*, *under*) as a within-subjects factor showed only a significant main effect of Age Group, $F_{2, 85} = 11.91$, $p < .001$, $\eta^2_p = .219$, driven by adults coloring more circles than children. Correlation across these terms showed that participants colored them similarly (Pearson's $r_{86} = .617$, $p < .001$). These analyses converge with our qualitative description above, showing that the representation of these two words are related, and changing, over development.

For *by* and *next to*, there was a less clear developmental pattern. Adults tended to color smaller representations for *by* than *next to*, with mean sizes for children in between. Variability between subjects was also higher for *next to* than *by*, with the exception of younger children (who were quite variable overall). A two-way ANOVA comparing sizes with Age Group as a between-subjects factor and Term (*by*, *next*) as a within-subjects factor showed no significant effects (*p*s > .48). Although the adults' means appear quite different, our study was under-powered to detect the difference in this analysis. Correlation across these terms was weak (Pearson's $r_{86} = .191$, $p = .075$), contrary to expectations.

Finally, for *between*, the mean size increased over development. A one-way ANOVA comparing sizes with Age Group as a between-subjects factor showed a significant effect, $F_{2, 85} = 5.32$ $p = .007$, $\eta^2 = .111$. This result is similar to the effect with *above* and *under*, showing broader representations in adults than in children.

Distance from Referent(s)

We next calculated the average distance of each colored circle from the referent(s) for each term by computing the number of neighboring colored circles extending from the referent on the *y*-axis (vertical) and *x*-axis (horizontal) separately. Vertical distances were coded as positive toward the top of the page and negative toward the bottom to preserve relevant directional information. Horizontal distances were coded positive (i.e., collapsing left and right). Because direction was irrelevant for *by* and *next to*, we also included a measure of Euclidean distance that each colored circle was from the referent object by adding each colored circle's squared distance from the referents on the *x*- and *y*-axes together, then taking the square root. For each distance measure, we calculated means separately for each participant for each term, shown in Figure 2. We focus our analyses on the potential differences of most interest based on the meaning of each term: vertical distance for *above* and *under*, Euclidean distance for *by* and *next to*, and horizontal distance for *between*.

A two-way ANOVA comparing vertical distances with Term (*above*, *under*) as a within-subjects factor and Age Group as a between-subjects factor showed a significant main effect of Term, $F_{1, 170} = 482.70$, $p < .001$, $\eta^2_p = .437$, which was subsumed by a significant Age Group x Term interaction, $F_{2, 170} = 46.93$, $p = .001$, $\eta^2_p = .042$. We compared means pair-wise to understand this interaction, and found that

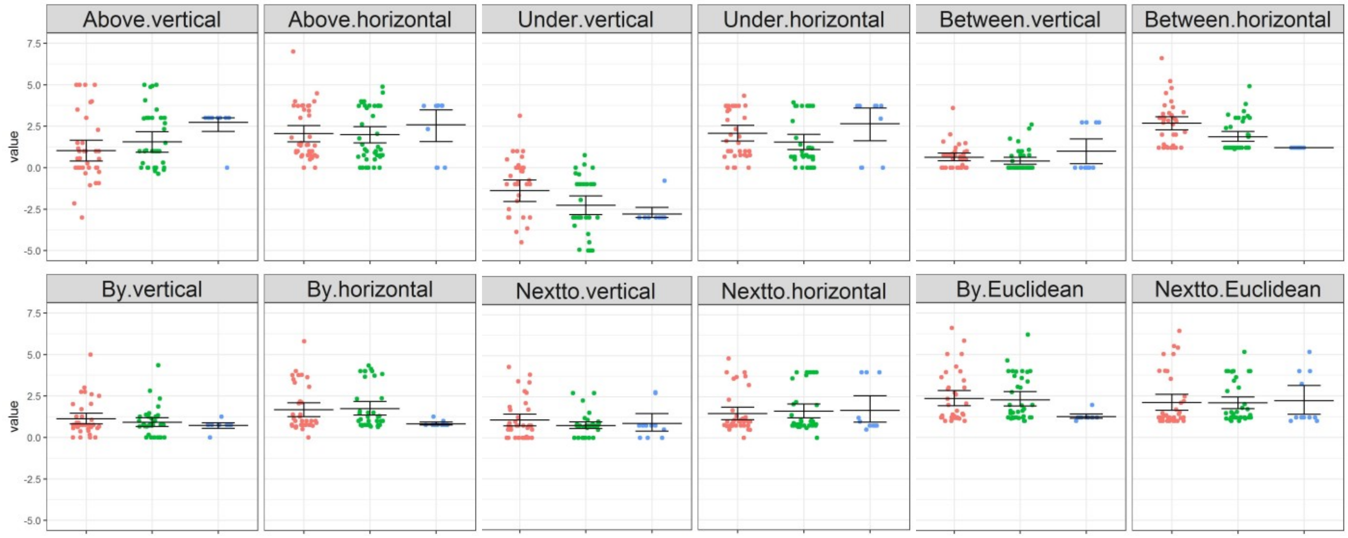

Figure 2. Mean distances (vertical and horizontal for all terms, plus Euclidean *by* and *next to*) across age groups (left/red dots = younger children, middle/green dots = older children, right/ blue dots = adults). Error bars show SE of the mean.

all *above-under* comparisons were significant (*p*s < .05), but comparisons within each term were not. The interaction was likely driven by opposite directions of developmental change across terms (positive for *above,* negative for *under*), which lead to larger differences across term for adults than children.

To compare this developmental change more directly, we conducted a parallel analysis with the sign reversed for *under* to see whether these terms differed reliably in distance from the referent, irrespective of direction. We analyzed the reversed vertical distance means for *under* with the same two-way ANOVA (comparing to *above*) and found a significant main effect of Age Group, $F_{2,\,170} = 46.93$, $p = .001$, $\eta^2_p = .075$. Pair-wise comparisons (*p*s < .05) showed that adults' and older children's distances from the referent were significantly larger than younger children's, but did not differ from each other. This result aligns with our size analysis, showing a general developmental trend for more extended representations. Together with the analysis of signed vertical distances, these results indicate that children were correctly locating *above* and *under* relative to the referent, and that the vertical extent of these terms increased over development.

For *by* and *next to* we conducted a two-way ANOVA comparing Euclidean distances with Term as a within-subjects factor and Age Group as a between-subjects factor. This analysis yielded no significant effects, likely due to low power in our sample of adults relative to the variance in responses for *next to* (see Figure 2).

Lastly, a one-way ANOVA comparing horizontal distances for *between* with Age Group as a between-subjects factor showed a significant effect, $F_{2,\,85} = 23.90$, $p < .001$, $\eta^2_p = .198$. Tukey HSD follow-up tests ($p < .05$) showed that adults and older children had smaller horizontal spans than younger children, but did not differ from each other.

Taken together, our quantitative analyses showed some predictable effects and some unexpected differences. For *above* and *under*, all age groups differentiated the vertical dimension, as expected. The vertical extent and size of these representations increased over development, which was not specifically predicted, but indicates an under-extension by younger children. For *by* and *next to*, there were no significant differences in size or distance, and sizes were not strongly correlated across terms despite similar meanings. Adults appeared to represent these terms differently, but our study was under-powered to determine whether this difference was reliable. For *between*, the size of representations increased over development (similar to *above* and *under*), but this difference was unexpectedly driven by changes along the vertical dimension, as the analysis of horizontal distance showed a developmental decrease.

Discussion

Our results provide a preliminary exploration of how children and adults represent five spatial terms in English. Qualitative analyses showed some differences in variability across participants by term, with the better agreement for the terms *above, under,* and *between* than for *by* and *next to*. The antonym terms *above* and *under* showed the expected opposite structures around the horizontal axis of the grid, as well as a developmental increase in vertical extent. Although *by* and *next to* may be considered synonyms, our categorization showed differentiation, and the sizes and distances of the representations was variable even within adults. As expected, children seemed to have the least consistent understanding of the term *between*, with their responses falling into more different categories than the other terms.

We had two general predictions for this study. First, we expected less variance across adults than children. All of our analyses (qualitative and quantitative) generally supported this prediction, although adults were notably more variable for the term *next to* than other terms. We anticipated a reduction in variability between younger and older children, but this only reached statistical significance in the horizontal distance for *between*. It is possible we could have found more significant changes during childhood if we had extended our age range to include older children, or if we had increased the difference between our age groups (e.g., comparing 3-year-olds to 5-year-olds) rather than using a median split in a continuous age range.

Our second hypothesis was that the size of representations would change over development, although it was unclear whether we should expect narrowing (suggesting over-extension in children) or broadening (suggesting under-extension in children). The terms *above, under, and between* all showed some evidence for broadening representations, specifically in the vertical dimension, over development. These results suggest that children may be under-extending these terms when they first learn them.

There are two limitations that should be considered in interpreting these results. First, our comparison of terms within the same participants may have influenced their responses. Inclusion of both *by* and *next to* may have led participants to intentionally differentiate their representation of these terms. We tried to reduce this influence by not presenting the terms sequentially (and including additional terms for adults) but cannot rule out such interactions, especially for adults who may have been approaching the task more meta-cognitively than children were.

Second, this task design may underestimate children's knowledge of these words. Although children's experience with picture books and coloring would give them practice with translating a vertical dimension to a sheet of paper, the sparse nature of the grid may have made this more challenging. It could be more effective to present grids upright (as on a computer screen) and/or to use simple scenes that include familiar objects. An added benefit of using familiar objects would be to map the developmental emergence of intrinsic reference frames in objects; adults show such effect, for example indicating that alignment with the opening of a bottle is *above* even if the bottle is horizontal (e.g., Carlson-Radvansky & Irwin, 1993).

In conclusion, our study provides initial evidence that spatial term representations shift systematically over development. Future studies should attempt to develop methods that can more closely align to real life uses of terms to gain a better understanding of how these concepts are represented. Theorists who are interested in the acquisition of spatial language should avoid characterizing comprehension and production as all-or-nothing knowledge and begin to assess the nature of children's representations as they gain experience hearing and producing spatial terms.

Acknowledgments

We are grateful to the families in Dane County, WI, who participated and to the research assistants in the SPACE Lab at the University of Wisconsin-Madison who collected the data. Funding for JMW to conduct this study was provided by the University of Wisconsin-Madison College of Letters & Sciences Honors Program through an Honors Senior Thesis Summer Research Grant, and funding for participant recruitment was provided by the Waisman Intellectual and Developmental Disabilities Research Center grant (P30HD03352) through the National Institutes of Health.

References

Carlson-Radvansky, L. A., & Irwin, D. E. (1993). Frames of reference in vision and language: Where is above? *Cognition*, *46*(3), 223–244. https://doi.org/10.1016/0010-0277(93)90011-J

Choi, S., & McDonough, L. (2007). Adapting Spatial Concepts for Different Languages: From Preverbal Event Schemas to Semantic Categories. In J. M. Plumert & J. P. Spencer (Eds.), *The emerging spatial mind* (pp. 142–167). New York, NY: Oxford University Press.

Clark, E. V. (1973). Non-linguistic strategies and the acquisition of word meanings. *Cognition*, *2*(2), 161–182.

Farran, E. K., & Atkinson, L. (2016). The development of spatial category representations from 4 to 7 years. *British Journal of Developmental Psychology*, *34*(4), 555–568. https://doi.org/10.1111/bjdp.12149

Foster, E. K., & Hund, A. M. (2012). The impact of scaffolding and overhearing on young children's use of the spatial terms between and middle. *Journal of Child Language*, *39*, 338–364.

Hund, A. M., & Naroleski, A. R. (2008). Developmental changes in young children's spatial memory and language in relation to landmarks. *Journal of Cognition and Development*, *9*(3), 310–339.

Li, P., Shusterman, A., & McNaughton, A. (2018). "Put your left hand in and shake it all about": The role of the body in children's acquisition of spatial terms. *Manuscript Submitted for Publication*. Retrieved from https://goo.gl/HRjn6P

Miller, H. E., & Simmering, V. R. (2018). Children's attention to task-relevant information accounts for relations between language and spatial cognition. *Journal of Experimental Child Psychology*, *172*, 107–209. https://doi.org/10.1016/j.jecp.2018.02.006

Miller, H. E., Vlach, H. A., & Simmering, V. R. (2017). Producing spatial words is not enough: Understanding the relation between language and spatial cognition. *Child Development*, *88*(6), 1966–1982. https://doi.org/10.1111/cdev.12664

Perry, L. K., & Saffran, J. R. (2017). Is a pink cow still a cow? Individual differences in toddlers' vocabulary knowledge and lexical representations. *Cognitive Science*, *41*(4), 1090–1105. https://doi.org/10.1111/cogs.12370

Verspoor, M., & Lowie, W. (2003). Making sense of polysemous words. *Language Learning*, *53*(3), 547–586. https://doi.org/10.1111/1467-9922.00234