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Short Communication

Two-year-olds consolidate verb meanings during a nap

Angela Xiaoxue He[a,b,*], Shirley Huang[c], Sandra Waxman[d], Sudha Arunachalam[e]

[a] Chinese University of Hong Kong, Brain and Mind Institute, Hong Kong, China
[b] University of Southern California, Department of Philosophy & Linguistics, United States of America
[c] University of Colorado Boulder, Department of Speech, Language, and Hearing Sciences, United States of America
[d] Northwestern University, Department of Psychology, United States of America
[e] New York University, Department of Communicative Sciences & Disorders, United States of America

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ABSTRACT

Successful word learning requires establishing an initial representation that is sufficiently robust to be retained in memory. Sleep has profound advantages for memory consolidation, but evidence concerning the effects of sleep in young children's word learning is slim and focuses almost exclusively on learning nouns. Verbs are representationally more complex and are often learned from non-concurrent linguistic and observational information (e.g., hearing "let's pour your milk" before the pouring event takes place). What remains unknown is whether initial representations built this way are robust enough to sustain a delay, and how these representations are affected by sleep. We presented two-year-olds with non-concurrent linguistic and observational information about novel verbs and immediately tested their knowledge of the verbs' meanings by evaluating their eye gaze as they looked at potential referents. Then, after a 4-hour delay during which half of the children napped and half remained awake, we retested them to see if they remembered the verbs' meanings. The results demonstrate differences in two-year-olds' representations of a novel verb before and after the delay; specifically, their verb representations withstood the 4-hour delay if they had napped, but decayed if they had remained awake.

1. Introduction

Young children learn new words quickly and then expand and refine their representations of meaning with increasing exposure (see He & Arunachalam, 2017, for a review on word learning). Children's initial representations of a novel word's meaning must therefore be sufficiently robust to be retained in memory until the next encounter. The evidence, thus far derived almost exclusively from the acquisition of novel nouns, suggests that initial representations are indeed retained. At issue, however, is whether young word learners encounter the same success in acquiring the meaning of novel verbs. Verbs pose an extra challenge because the initial representations are often gleaned from "fragmented" input. Caregivers rarely label events while they are ongoing, and so the learner cannot observe the referent event while hearing the verb (e.g., Gleitman & Gleitman, 1992; Tomasello & Kruger, 1992). In situations like this, when linguistic and observational information become available at different time points, are young word learners' initial representations sufficiently robust to sustain a delay?

Years of research have established that both linguistic and observational context provide important information about verb meaning (e.g., Gillette, Gleitman, Gleitman, & Lederer, 1999; Gleitman, 1990; Landau & Gleitman, 1985). The linguistic context provides structural information; for example, *blick* in "the boy blicked the girl" denotes a causative event whereas in "the boy and the girl blicked," it denotes a non-causative event. The observational context further instantiates the semantic content of the event (e.g., how a blicking event unfolds). These two sources of information, however, are often temporally "fragmented." Over half of the verbs in child-directed speech refer to events that occur after the verb has been uttered (e.g., "Let's pour some milk into the glass") (Tomasello & Kruger, 1992). Nevertheless, 2-year-old children successfully harvest this fragmented input, integrating linguistic information about a novel verb (e.g., a conversation between two actors who use the verb in informative sentences) with observational evidence about its meaning (e.g., Arunachalam, 2013; Arunachalam, Escovar, Hansen, & Waxman, 2013; Arunachalam & Waxman, 2010; Dautriche et al., 2014; Messenger, Yuan, & Fisher, 2015; Scott & Fisher, 2009; Yuan & Fisher, 2009). For example, Arunachalam and Waxman (2010) and Arunachalam et al. (2013) introduced children to novel verbs, presented in either transitive or intransitive syntactic frames in a dialogue between two actors, without

* Corresponding author at: 4F, Hui Yeung Shing Bldg, CUHK, Sha Tin, N.T., Hong Kong, China.
E-mail address: angelahe@cuhk.edu.hk (A.X. He).

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providing any visual cues to the verb's meanings. Children were subsequently shown two candidate referent scenes, one in which one actor performed a causative action on the other (e.g., spinning) and another in which the two actors engaged in independent non-causative actions (e.g., waving). Children mapped novel verbs presented in transitive frames, but not verbs in intransitive frames, to the causative scene. Because these representations were established from temporally fragmented input, they may well be fragile. Our goal in the current investigation is to test children's ability to retain such fragmented representations over a delay.

Although the evidence for retaining initial representations of novel nouns over delays is promising (e.g., Carey & Bartlett, 1978; Dollaghan, 1985; Golinkoff, Hirsh-Pasek, Bailey, & Wenger, 1992; Goodman, McDonough, & Brown, 1998; Heibeck & Markman, 1987; Jaswal & Markman, 2001, 2003; Markson & Bloom, 1997; Mervis & Bertrand, 1994; Waxman & Booth, 2000; Wilkinson & Mazzitelli, 2003; Wilkinson, Ross, & Diamond, 2003; Woodward, Markman, & Fitzsimmons, 1994),[1] the evidence concerning verb learning is considerably sparser. Yuan and Fisher (2009) reported that 28-month-olds retained an initial verb representation after a delay of one or two days. This is impressive, but because delays of this duration necessarily include sleep, it raises a compelling question: Is sleep an essential ingredient in maintaining verb representations over delays? In the current investigation, we address this directly, introducing a shorter delay period during which we manipulate whether or not the child napped.

There is substantial evidence that new memories are *consolidated* during sleep— stabilized, strengthened, and integrated into long-term memory (Diekelmann & Born, 2010; Rasch, Büchel, Gais, & Born, 2007), and that short naps also have a consolidation effect (e.g., Lahl, Wispel, Willigens, & Pietrowsky, 2008). Young children tend to sleep longer at night than adults and typically take daytime naps (Iglowstein, Jenni, Molinari, & Largo, 2003; Ohayon, Carskadon, Guilleminault, & Vitiello, 2004; Weissbluth, 1995). But what remains unclear is whether young word learners' retention and retrieval of initial representations of novel words are affected by sleep. Some studies report a sleep advantage (e.g., Friedrich, Wilhelm, Born, & Friederici, 2015; Horváth, Myers, Foster, & Plunkett, 2015; Williams & Horst, 2014), but others do not (Werchan & Gómez, 2014). And again, most existing evidence is on nouns.

To our knowledge, there is only a single report of the effect of sleep in learning verbs. Sandoval, Leclerc, and Gómez (2017) found that only children who napped shortly after learning, but not those who stayed awake, retained and generalized the meaning of novel verbs. However, because the novel verbs in their design were presented concurrently with a referent scene, this work cannot address the acquisition of meaning when they must lay down an initial representation based on the linguistic context alone, and then integrate it with observational information when it later becomes available.

To assess how fragmented representations of verb meaning fare over a delay, we invited 2-year-old children and their parents to participate in a study with the two distinct visits (*Visit 1* and *Visit 2*) separated by a 4-h delay during which the child either slept (*Nap Condition*) or remained awake (*Wake Condition*). We compared performance across the two visits to ascertain whether children's initial representations of novel verb meanings were sufficiently robust to withstand a delay and whether their representations were enhanced with sleep. Specifically, we predicted that children would retain initial representations if the delay included sleep, but that without sleep, the representations would decay.

We take as a starting point the robust evidence that children successfully establish an initial representation of a novel verb even from fragmented input (e.g., Arunachalam, 2013; Arunachalam & Waxman, 2010; Yuan & Fisher, 2009). Adopting the stimuli and design of Arunachalam and Waxman (2010), we focus specifically on learning novel *transitive* verbs, asking whether and how children's verb learning is affected by a delay with or without sleep. We target 27-month-olds, children in an active phase of acquiring new verbs.

2. Methods

2.1. Participants

Forty-two typically-developing, monolingual English-learning children (21 females, 21 males; ages 25.1–29.9 months, mean = 26.8 months) were included in the final sample. Parents reported that all children typically took a daytime nap. We randomly assigned children to the Nap or Wake Condition, adjusting the time of their lab visits so that for half, Visit 1 was before their regular nap time and Visit 2 after, and for the remaining half, Visit 1 and 2 did not span their typical nap time. Families received $25 compensation for participation. Fourteen additional children participated but were excluded from analysis because of failure to conform to condition assignment (5) (see Supplementary Materials), fussiness (5), failure to return for Visit 2 (1), or insufficient eye-tracking data (3).[2]

2.2. Stimuli

The visual and auditory stimuli were identical to those reported in Arunachalam et al. (2013). See Fig. 1.

2.3. Procedure

Visits 1 and 2 were separated by a delay of 4 h. At Visit 1, the parent provided informed consent while the child played with an experimenter. Next, they escorted to the testing room, where the child sat 18 in. from the eye-tracker monitor, either in a car seat or on the parent's lap. Each visit included four different trials, each comprising a *Dialogue Phase* and a *Test Phase*, featuring a different novel verb. See Fig. 1 for an example trial and Supplementary Materials for all trials.

In the *Dialogue Phase*, the actors mentioned the novel verb 8 times, always in transitive frames (e.g., “The boy is going to *biff* the lady”). Only linguistic cues to the novel verb's meaning were available. In the *Test Phase*, observational materials were presented, with sentences stripped of informative syntax. This phase consisted of three windows: (1) *Salience*: Children heard “Look!” and saw the two test scenes simultaneously on opposite sides of the screen—one depicting a causative event and the other a non-causative event; (2) *Central Fixation*: Children saw a centered yellow star to draw attention to the midpoint of the screen and heard a prompt (e.g., “Where's *moop*ing?”); (3) *Response*: The two test scenes reappeared in their original locations, and the child heard another prompt (e.g., “Do you see *moop*ing?”) and another 2 s later (e.g., “Find *moop*ing”).

After Visit 1, the child and parent left the lab, returning for Visit 2 approximately 4 h later. Visit 2 included only the *Test Phase* for each trial, no *Dialogue Phase*. Therefore, to succeed, children had to retrieve their initial representations for the novel verbs—without the benefit of additional linguistic support—and use them to identify the causative test scenes.

2.4. Sleep information

Parents logged their child's sleep/wake activities at 30-minute intervals throughout the 4-hour delay. We also collected parental reports

[1] But see Friedrich and Friederici (2011), Horst and Samuelson (2008), Kucker and Samuelson (2011), Munro, Baker, McGregor, Docking, and Arciuli (2012), and Vlach and Sandhofer (2012).

[2] Trials with > 55% loss of eye-tracking data due to blinks or other tracking failures were excluded; a participant was excluded if all of his/her trials on a visit were excluded.

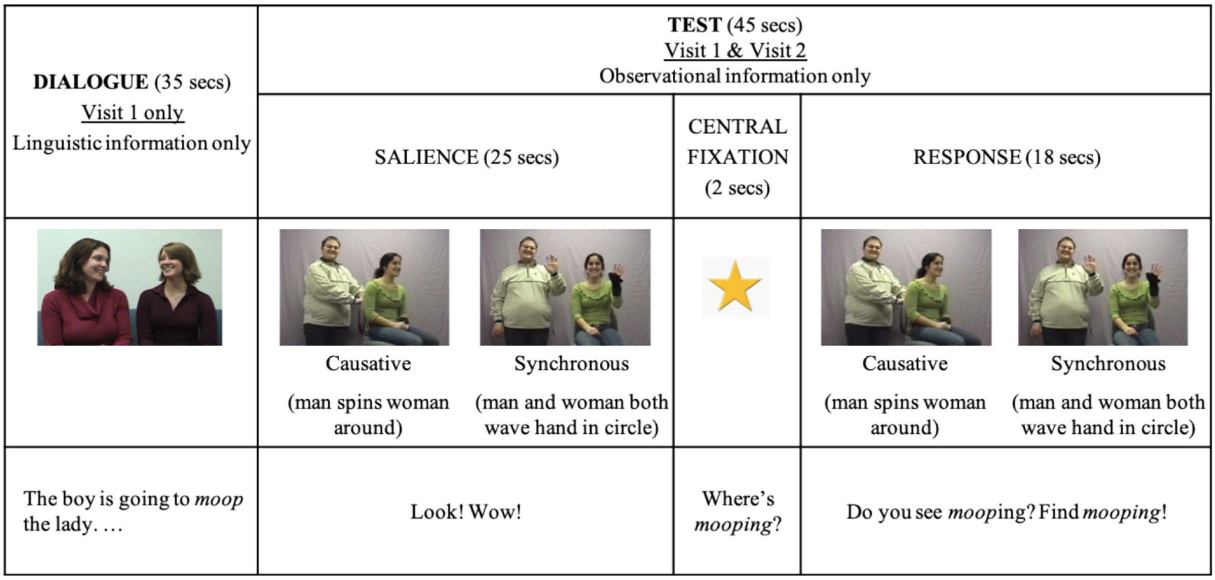

Fig. 1. Design of one example trial (from a total of 4). The visual stimuli were recordings of live actors in conversation and live actors acting on other actors or on objects. The auditory stimuli were recordings of a female native English speaker speaking in child-directed speech. The materials were presented on a 24-inch widescreen eye-tracker monitor (Tobii T60XL; Studio 2.0), which recorded the coordinates of children's gaze at a rate of 60 frames/s.

on children's typical sleep hours outside of the context of the study. See the Supplementary Materials for more information.

2.5. Coding and analysis

Data points where no eye gaze was captured (e.g., blinks) were excluded (15% of all data points). The included data were then coded at each frame, as 1 (gaze directed to the causative scene) or 0 (directed to either the synchronous scene or to neither scene). We focused on the first 2.5 s of the Test Response window as in Arunachalam et al. (2013), calculating the proportion of frames on which gaze was directed to the causative scene for each participant on each trial out of all frames on which a valid gaze coordinate was recorded (i.e., excluding blinks but including looks to neither scene). If sleep strengthens children's initial verb representations, this should be expressed in a Condition x Visit interaction.

2.6. Results and discussion

At Visit 1, children's mean proportion of looking to the causative scene in the Nap Condition was 0.41 (SD = 0.17), and in the Wake Condition, 0.43 (SD = 0.13). At Visit 2, mean target look was 0.48 (SD = 0.19) and 0.40 (SD = 0.13) in the Nap and Wake Condition respectively. To assess whether and how looking time in each condition and each visit varied over the course of 2.5 s, we submitted the data to a Growth Curve Analysis (Mirman, 2014), with Condition and Visit as fixed effects, Time as a continuous predictor, and Participant as a random factor. We fit the data with a first-order linear model and a second-order orthogonal polynomial model. Because the latter provided a better fit ($\chi^2(9) = 1196$, $p < 0.001$, $\Delta AIC = -1178$, $\Delta BIC = -1121$), we report the second-order model. Statistical significance for individual parameter estimates was evaluated using an alpha level of 0.05, using normal approximation (i.e., *t*-values treated as *z*-values). See Fig. 2.

The model yielded a main effect of Visit ($t = 3.09$, $p = 0.002$) and a Condition x Visit interaction ($t = 6.32$, $p < 0.001$). To better capture the interaction, we submitted data from each condition separately to a second-order orthogonal polynomial model, with Visit as a fixed effect, Time as a continuous predictor, and Participant as a random variable. In the Nap condition, the proportion of attention devoted to the causative scene increased from Visit 1 to Visit 2 ($p < 0.001$, $\beta = 0.25$); in the Wake Condition, this proportion decreased ($p = 0.014$, $\beta = -0.085$). This reveals that children's initial verb representations, built upon fragmented information, were enhanced with sleep, an outcome consistent with evidence that initial encodings are strengthened and consolidated with sleep (see Diekelmann & Born, 2010, for review). See Supplementary Materials for more details about the models.

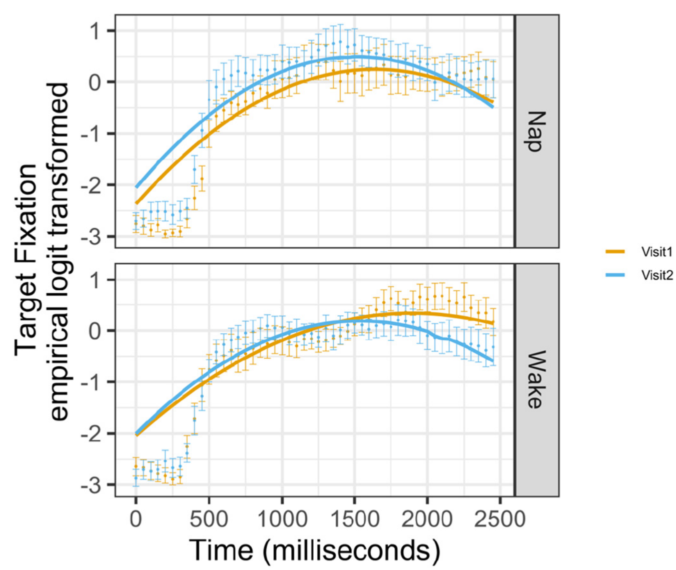

Fig. 2. Fixation time course and growth curve model fit.

3. General discussion

Young children acquire vocabulary at an astonishing rate. Doing so requires that they not only identify the referent of a new word, but also retain their representation of that word's meaning over a delay until the word is encountered again. In the current work, we have focused on verb learning in particular, because typically the linguistic and observational information are decoupled—children often hear a novel verb in an utterance without the benefit of concurrent observational information (e.g., Tomasello & Kruger, 1992). At issue then was whether children'zs initial representations for verbs, formed from this “fragmented” input, were too fragile to withstand delays. Given the role of sleep in learning and memory, we asked whether a daytime nap would better support retention of a novel verb representation over a delay than a period of wakefulness. We found that 27-month-olds' initial verb representations withstood a delay of 4 h if sleep was included; without sleep, the representations decayed over the delay.

This result provides several new insights. First, it provides evidence that children's representations, built upon fragmented input are indeed fragile and subject to decay. Second, these representations, although sparse, are nonetheless sufficient to be retained so that sleep-related memory consolidation can bolster them. This outcome converges well with other evidence on the behavioral, cognitive, and neurodevelopmental benefits of sleep (e.g., Dahl, 1999; Fondell et al., 2011; Hill, Hogan, & Karmiloff-Smith, 2007; Jansen et al., 2011; Touchette et al., 2007).

Third, the current results move beyond seminal work of Yuan and Fisher (2009) in two crucial ways. First, we systematically manipulated sleep; half of the children napped in the delay and half remained wakeful. This manipulation permitted us to test the effect of sleep directly. Second, Yuan and Fisher (2009) imposed a delay between the linguistic exposure, waiting a day or two before providing the observational input. Thus, they tested retention of a representation formed from linguistic information alone. In contrast, children in the current experiment retained a representation built from both linguistic and observational input, presented at different times. The current finding suggests that although this temporal gap between linguistic and observational information may indeed result in fragile representations, memory consolidation during sleep offers one key to integrating them.

Two additional key questions remain. First, what is the nature of the representations that children formed? At Visit 1, children encountered four different novel verbs, all transitive, each depicting a different causative event. To succeed at Visit 2, they could have remembered a) only the linguistic representation established from the Dialogue Phase—that the verb was transitive, b) only the mapping between each verb and its event referent (e.g., *moop* names the event where one person spins another), or c) both—that the verb was transitive as well as its specific event referent. Ideally, learners would remember both, because this would allow them to distinguish a “mooping” event from other causative events. But the current design cannot tease these apart.

Second, what is the mechanism underlying sleep-related memory consolidation? Does sleep consolidate the initial representation, or simply remove interference from the external stimuli that one would naturally encounter while awake? If the latter, we would expect a wakeful delay that is restful, with minimal external stimuli, would serve the same purpose as a nap. A control condition with children staying awake but engaging in minimal activity would potentially disentangle these possibilities, but we imagine this would be very difficult to carry out with young children. Nevertheless, we think it is unlikely that the nap provided only protection from interference. Importantly, we found an increase in looking to the target scene in the Nap condition, rather than simply no change. Moreover, research on consolidation of other kinds of memories (specifically, visuospatial declarative memories) indicates that naps provide more than just protection against interference for preschoolers (Kurdziel, Duclos, & Spencer, 2013).

In sum, although questions concerning the contribution of sleep remain, the current results reveal that sleep is a key ingredient to the recipe of learning.

Credit author statement

S.A. and S.R.W. conceived of and designed the study. S.H. collected and coded data. A.X.H. coded and analyzed the data. A.X.H. drafted the manuscript, S.A., A.X.H., and S.R.W., edited the manuscript, and S.H provided comments.

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Declaration of conflicting interest

The authors have no conflicts of interest to declare.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.cognition.2020.104205.

References

Arunachalam, S. (2013). Two-year-olds can begin to acquire verb meanings in socially impoverished contexts. *Cognition, 129*(3), 569–573. https://doi.org/10.1016/j.cognition.2013.08.021.

Arunachalam, S., Escovar, E., Hansen, M. A., & Waxman, S. R. (2013). Out of sight, but not out of mind: 21-month-olds use syntactic information to learn verbs even in the absence of a corresponding event. *Language and Cognitive Processes, 28*(4), 417–425. https://doi.org/10.1080/01690965.2011.641744.

Arunachalam, S., & Waxman, S. R. (2010). Meaning from syntax: Evidence from 2-year-olds. *Cognition, 114*(3), 442–446. https://doi.org/10.1016/j.cognition.2009.10.015.

Carey, S., & Bartlett, E. (1978). Acquiring a single new word. *Papers and Reports on Child Language Development, 15*, 17–29.

Dahl, R. E. (1999). The consequences of insufficient sleep for adolescents - links between sleep and emotional regulation. *Phi Delta Kappan, 80*(5), 179–189. https://doi.org/10.2307/20439447.

Dautriche, I., Cristia, A., Brusini, P., Yuan, S., Fisher, C., & Christophe, A. (2014). Toddlers default to canonical surface-to-meaning mapping when learning verbs. *Child Development, 85*(3), 1168–1180. https://doi.org/10.1111/cdev.12164.

Diekelmann, S., & Born, J. (2010). The memory function of sleep. *Nature Reviews Neuroscience, 11*, 114–126. https://doi.org/10.1038/nrn2762.

Dollaghan, C. (1985). Child meets word: “Fast mapping” in preschool children. *Journal of Speech Language and Hearing Research, 28*(3), 449–454.

Fondell, E., Axelsson, J., Franck, K., Ploner, A., Lekander, M., Bälter, K., & Gaines, H. (2011). Short natural sleep is associated with higher T cell and lower NK cell activities. *Brain, Behavior, and Immunity, 25*(7), 1367–1375. https://doi.org/10.1016/j.bbi.2011.04.004.

Friedrich, M., & Friederici, A. D. (2011). Word learning in 6-month-olds: Fast encoding-weak retention. *Journal of Cognitive Neuroscience, 23*(11), 3228–3240. https://doi.org/10.1162/jocn_a_00002.

Friedrich, M., Wilhelm, I., Born, J., & Friederici, A. D. (2015). Generalization of word meanings during infant sleep. *Nature Communications, 6*, 6004. https://doi.org/10.1038/ncomms7004.

Gillette, J., Gleitman, H., Gleitman, L. R., & Lederer, A. (1999). Human simulations of vocabulary learning. *Cognition, 73*(2), 135–176. https://doi.org/10.1016/S0010-0277(99)00036-0.

Gleitman, L. R. (1990). The structural sources of verb meanings. *Language Acquisition, 1*(1), 3–55. https://doi.org/10.1207/s15327817la0101_2.

Gleitman, L. R., & 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*(1), 31–35. https://doi.org/10.1111/1467-8721.ep10767853.

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), 99–108. https://doi.org/10.1037/0012-1649.28.1.99.

Goodman, J. C., McDonough, L., & Brown, N. B. (1998). The role of semantic context and memory in the acquisition of novel nouns. *Child Development, 69*(5), 1330–1344. https://doi.org/10.1111/j.1467-8624.1998.tb06215.x.

He, A. X., & Arunachalam, S. (2017). Word learning mechanisms. *Wiley Interdisciplinary Reviews: Cognitive Science, 8*(4), https://doi.org/10.1002/wcs.1435.

Heibeck, T. H., & Markman, E. M. (1987). Word learning in children: An examination of fast mapping. *Child Development, 58*(4), 1021–1034. https://doi.org/10.1111/j.1467-8624.1987.tb01438.x.

Hill, C. M., Hogan, A. M., & Karmiloff-Smith, A. (2007). To sleep, perchance to enrich learning? *Archives of Disease in Childhood, 92*(7), 637–643. https://doi.org/10.1136/adc.2006.096156.

Horst, J. S., & Samuelson, L. K. (2008). Fast mapping but poor retention by 24-month-old infants. *Infancy, 13*(2), 128–157. https://doi.org/10.1080/1525O(xH)701795598.
Horváth, K., Myers, K., Foster, R., & Plunkett, K. (2015). Napping facilitates word learning in early lexical development. *Journal of Sleep Research, 24*(5), 503–509. https://doi.org/10.1111/jsr.12306.
Iglowstein, I., Jenni, O. G., Molinari, L., & Largo, R. H. (2003). Sleep duration from infancy to adolescence: Reference values and generational trends. *Pediatrics, 111*(2), 302–307. https://doi.org/10.1542/peds.111.2.302.
Jansen, P. W., Saridjan, N. S., Hofman, A., Jaddoe, V. W. V., Verhulst, F. C., & Tiemeier, H. (2011). Does disturbed sleeping precede symptoms of anxiety or depression in toddlers? The Generation R study. *Psychosomatic Medicine, 73*(3), 242–249. https://doi.org/10.1097/PSY.0b013e31820a4abb.
Jaswal, V. K., & Markman, E. M. (2001). Learning proper and common names in inferential versus ostensive contexts. *Child Development, 72*(3), 768–786.
Jaswal, V. K., & Markman, E. M. (2003). The relative strengths of indirect and direct word learning. *Developmental Psychology, 39*(4), 745–760. https://doi.org/10.1037/0012-1649.39.4.745.
Kucker, S. C., & Samuelson, L. K. (2011). The first slow step: Differential effects of object and word-form familiarization on retention of fast-mapped words. *Infancy, 17*(3), 295–323. https://doi.org/10.1111/j.1532-7078.2011.00081.x.
Kurdziel, L., Duclos, K., & Spencer, R. M. C. (2013). Sleep spindles in midday naps enhance learning in preschool children. *Proceedings of the National Academy of Sciences, 110*(43), 17267–17272. https://doi.org/10.1073/pnas.1306418110.
Lahl, O., Wispel, C., Willigens, B., & Pietrowsky, R. (2008). An ultra short episode of sleep is sufficient to promote declarative memory performance. *Journal of Sleep Research, 17*, 3–10. https://doi.org/10.1111/j.1365-2869.2008.00622.x.
Landau, B., & Gleitman, L. R. (1985). *Language and experience: Evidence from the blind child.* Cambridge, MA: Harvard University Press.
Markson, L., & Bloom, P. (1997). Evidence against a dedicated system for word learning in children. *Nature, 385*(6619), 813–815. https://doi.org/10.1038/385813a0.
Mervis, C. B., & Bertrand, J. (1994). Acquisition of the novel name–nameless category (N3C) principle. *Child Development, 65*(6), 1646–1662. https://doi.org/10.1111/j.1467-8624.1994.tb00840.x.
Messenger, K., Yuan, S., & Fisher, C. (2015). Learning verb syntax via listening: New evidence from 22-month-olds. *Language Learning and Development, 11*(4), 356–368. https://doi.org/10.1080/15475441.2014.978331.
Mirman, D. (2014). *Growth curve analysis and visualization using R* (1st ed.). New York City, NY: Chapman and Hall/CRC.
Munro, N., Baker, E., McGregor, K., Docking, K., & Arciuli, J. (2012). Why word learning is not fast. *Frontiers in Psychology, 3*. https://doi.org/10.3389/fpsyg.2012.00041.
Ohayon, M. M., Carskadon, M. A., Guilleminault, C., & Vitiello, M. V. (2004). Meta-analysis of quantitative sleep parameters from childhood to old age in healthy individuals: Developing normative sleep values across the human lifespan. *Sleep, 27*(7), 1255–1273.
Rasch, B., Büchel, C., Gais, S., & Born, J. (2007). Odor cues during slow-wave sleep prompt declarative memory consolidation. *Science, 315*, 1426–1429. https://doi.org/10.1126/science.1138581.
Sandoval, M., Leclerc, J. A., & Gómez, R. L. (2017). Words to sleep on: Naps facilitate verb generalization in habitually and nonhabitually napping preschoolers. *Child Development, 88*(5), 1615–1628. https://doi.org/10.1111/cdev.12723.
Scott, R. M., & Fisher, C. (2009). Two-year-olds use distributional cues to interpret transitivity-alternating verbs. *Language and Cognitive Processes, 24*(6), 777–803. https://doi.org/10.1080/01690960802573236.
Tomasello, M., & Kruger, A. C. (1992). Joint attention on actions: Acquiring verbs in ostensive and non-ostensive contexts. *Journal of Child Language, 19*(2), 311–333.
Touchette, E., Petit, D., Séguin, J. R., Boivin, M., Tremblay, R. E., & Montplaisir, J. Y. (2007). Associations between sleep duration patterns and behavioral/cognitive functioning at school entry. *Sleep, 30*(9), 1213–1219. https://doi.org/10.1093/sleep/30.9.1213.
Vlach, H. A., & Sandhofer, C. M. (2012). Fast mapping across time: Memory processes support children's retention of learned words. *Frontiers in Psychology,* 3. https://doi.org/10.3389/fpsyg.2012.00046.
Waxman, S. R., & Booth, A. E. (2000). Principles that are invoked in the acquisition of words, but not facts. *Cognition, 77*(2), B33–B43. https://doi.org/10.1016/S0010-0277(00)00103-7.
Weissbluth, M. (1995). Naps in children: 6 Months-7 years. *Sleep, 18*(2), 82–87. https://doi.org/10.1093/sleep/18.2.82.
Werchan, D. M., & Gómez, R. L. (2014). Wakefulness (not sleep) promotes generalization of word learning in 2.5-year-old children. *Child Development, 85*(2), 429–436. https://doi.org/10.1111/cdev.12149.
Wilkinson, K. M., & Mazzitelli, K. (2003). The effect of "missing" information on children's retention of fast-mapped labels. *Journal of Child Language, 30*(1), 41–73. https://doi.org/10.1017/s0305000902005469.
Wilkinson, K. M., Ross, E., & Diamond, A. (2003). Fast mapping of multiple words: Insights into when "the information provided" does and does not equal "the information perceived". *Journal of Applied Developmental Psychology, 24*(6), 739–762. https://doi.org/10.1016/j.appdev.2003.09.006.
Williams, S. E., & Horst, J. S. (2014). Goodnight book: Sleep consolidation improves word learning via storybooks. *Frontiers in Psychology, 5*(MAR), https://doi.org/10.3389/fpsyg.2014.00184.
Woodward, A. L., Markman, E. M., & Fitzsimmons, C. M. (1994). Rapid word learning in 13- and 18-month-olds. *Developmental Psychology, 30*(4), 553–566. https://doi.org/10.1037/0012-1649.30.4.553.
Yuan, S., & Fisher, C. (2009). "Really? She blicked the baby?" Two-year-olds learn combinatorial facts about verbs by listening. *Psychological Science, 20*(5), 619–626. https://doi.org/10.1111/j.1467-9280.2009.02341.x.