ISOLATING THE EFFECT OF NAPS ON VERB-GENERALIZATION
IN 3 YEAR-OLDS

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Abstract

Research has shown that young children tend to pay more attention to objects than to the motions of or relationships between objects, and in order to get past this tendency, children need to see the verb performed multiple times by the same exemplars. This suggests that children are limited in their ability to generalize upon first learning a verb. Given research that sleep promotes generalization, this study investigates the role of napping in verb-generalization of three year olds. In Experiment 1 participants were trained on new verbs and tested on generalization immediately, and in Experiment 2 participants were trained on verbs and tested after a 4.5 hour delay which included a nap. Participants in Experiment 1 did not generalize the verbs at significantly higher-than-chance score. Participants in Experiment 2 also did not generalize the verbs at a significantly higher-than-chance score, but the mean approached significance and possibly created a trend with previously reported data. Compared with previous studies, these results indicate that (1) sleep plays an active role in verb-generalization and (2) verb-generalization may be the result of a combination of nap and nighttime sleep.
The Effect of Sleep on Verb-Learning in 3 Year-Olds

When we think about the different aspects of language and their functions, all of which infants learn and use by the time they reach toddlerhood, it makes sense that verbs would be more difficult to learn than other parts of speech. Where nouns typically deal with objects, verbs deal with the relationships between objects; that is to say, beyond just identifying objects, verbs deal with what the objects are actually doing. A 2002 study by Kersten and Smith found that children tend to have an object bias when learning, meaning regardless of if they are exposed to a novel object by itself or to novel objects performing novel actions, they attend almost exclusively to the appearance of the object (Kersten and Smith, 2002).

How, then, do children overcome this bias in order to learn verbs? Maguire, Hirsch-Pasek, Golinkoff, & Brandone (2008) investigated two possible explanations. The first was that children learn verbs only after seeing multiple exemplars of the action in different contexts. By seeing the action performed by different actors or between different objects, they can focus on the commonality of the exemplars— the action itself—and can then match that action with the associated verb. Conversely, the second hypothesis was that children need to see one exemplar of the action repeated multiple times to generalize because they must essentially habituate to the actors or objects before shifting their attention to the action itself. The Maguire study tested both hypotheses by teaching three year olds novel verbs using videos of either one actor repeating the same novel action four times, or of four different actors performing the novel action once each. When then tested on the verb, participants in the one actor condition performed significantly better than those in the four actor condition, who overall performed at chance level, indicating that toddlers initially learn verbs by repeated exposure to the same exemplar, and only then can begin to generalize (Maguire 2008).
Knowing that generalization is a key part of learning a verb and using the paradigm established by Maguire et al. (2008), Sandoval & Gómez (2015) have taken the question of how toddlers learn verbs a step further by incorporating an element of sleep. There has been ample research indicating that sleep promotes both memory consolidation and generalization in infants (Hupbach, Gómez, & Nadel, 2009; Gómez, Bootzin, & Nadel, 2006). Sleep improves generalization by helping infants to essentially forget the irrelevant details and consolidate the important ones. Given the evidence that sleep promotes generalization of an artificial language, and that three year olds are restricted in their ability to generalize verbs upon first learning them (Maguire et al., 2008), Sandoval and Gómez investigated whether napping shortly after learning a new verb would improve three year olds’ ability to generalize their learning 24 hours later. By using a design similar to Maguire et al. but testing participants 24 hours later, Sandoval and Gómez found that three year olds who napped shortly after learning performed significantly better on a generalization test than their counterparts who stayed awake for at least five hours after learning, and the three year olds who stayed awake after learning did not perform above chance. The finding of Sandoval and Gómez (2015) raises two questions about verb-learning in three year olds which the present study seeks to address: Experiment 1 investigates if the difference in performance after a period of sleep versus wake is due to an active role of sleep, or if conversely, the decreased performance after a period wake can be explained by forgetting. If the effect is in fact due to an active role of sleep, rather than a deteriorating role of wake, three year olds tested on generalization immediately after training will not perform significantly above chance, indicating that the improved generalization only comes after sleeping. Experiment 2 will investigate if this effect emerges after a nap alone, or after some combination of nap plus nighttime sleep. If a nap alone is enough to significantly improve verb-generalization, three year
olds tested after a 4.5 hour delay including a nap will perform significantly above chance, just as in the 24 hour delay data reported by Sandoval and Gómez.

Kurdziel et al. have already begun to investigate the differences in sleep architecture between adults and young children, and have found some evidence that the same learning which would be consolidated during a toddler’s midday nap may not be able to be consolidated during night sleep, indicating that the nap itself may be the crucial factor in learning (2013). Since the present study distinguishes between naps and nighttime sleep, the results may have implications for our understanding of the sleep architecture of young children. By exploring the individual effect of a nap alone, the study may also potentially change the way parents and teachers think about the necessity of naps in early childhood and their effect on learning.

Method

Participants

The study consisted of 18 participants, nine per condition. Participants were three year olds from the Tucson area, recruited from local events such as the Tucson Baby Fair and from previous studies in the UA Cognition Lab. To qualify as habitual nappers and participate in the study, participants had to regularly nap four days or more per week.

Materials

Training

Training videos consisted of eight-second clips of a single actor performing a novel action accompanied by a voiceover of the associated novel verb. Per Maguire et al. (2008), each clip was repeated four times and separated by an image of a baby as an attention-getter. Participants were each trained on two novel verbs.
Test videos consisted of clips of the two actions from training performed by different actors and projected side-by-side, accompanied by a prompt to point to one of the associated verbs.

Procedure

Experiment 1. Participants were scheduled to come into the lab at any time of the day that did not interfere with their regular nap schedule. First they were shown a three-minute video which taught them two new verbs, “rooping” and “blicking.” After watching the training video on a laptop, participants then went into a booth where they were tested on their ability to generalize the verbs they just learned. Projected on the screen were side-by-side clips of different actors performing the two actions, and participants were prompted to point to the correct action for each word (e.g. “Point to the girl who’s blicking. Can you point to the girl who’s blicking?”).
This process was repeated over four trials, with the correct answer being counterbalanced such that participants who pointed only to one side would receive a chance score of 50%.

**Experiment 2.** Following the design used by Sandoval and Gómez (2015), participants were scheduled for a two-part appointment; the first part would take place at the participant’s home about one hour before he or she was expected to nap, but to encompass the nap alone, the second part of the appointment was after a 4.5 hour delay, instead of the 24 hour delay used by Sandoval and Gómez. Participants watched the training video at their home before taking a nap, and were asked to wear a body-movement monitor as an objective measure of their sleep to verify parent report. Four and a half hours later at the lab, participants were tested on the verbs using the same method as in Experiment 1. All participants in both experiments also completed a Peabody Picture Vocabulary Test for supplemental data.

**Results**

The dependent measure used in the analyses was proportion correct, with a score of 1.0 reflecting perfect performance.

**Experiment 1**

When tested on verb-generalization immediately after training, participants did not perform significantly above chance, score overall ($M = 0.528, SD = 0.363$), $t(8) = 0.229$, $p > .05$ (See Figure 3). Despite a fair amount of variability among participants, this result indicates that three year olds as a whole are not able to immediately generalize a newly-learned verb to new contexts, and that the difference reported in Sandoval and Gómez (2015) was likely due to an active, rather than a protective, role of sleep.
Experiment 2

For participants tested after a 4.5 hour delay including a nap, generalization was numerically above chance, but only approached significance ($M = 0.639, SD = 0.253), t(8) = 1.644, p=0.06$. Though the results are not statistically significant, the mean scores are closer to the 24 hour delay scores reported by Sandoval and Gómez (2015) than they are to the immediate scores of Experiment 1. This suggests that the effect reported in Sandoval and Gómez may be due to a combination of nap plus nighttime sleep, though due to the small n-size, we cannot yet rule out the possibility that the nap alone may be enough to promote generalization.

![Three-Year-Old Verb Generalization](image)

*Figure 3. Three year old verb-generalization. This graph shows the mean generalization score for Experiment 1 (Immediate), Experiment 2 (4.5 hr), and Sandoval and Gomez (2015) for comparison.*

Discussion

Taken together, the results of Experiment 1 and Experiment 2, along with the results reported by Sandoval & Gómez (2015), indicate that (1) sleep plays an active role in verb-generalization in three year olds and (2) generalization *may* be a result of the combination of a
nap and a night’s sleep, if the nap alone is not enough to promote generalization. Sandoval and Gómez found that three year olds who stayed awake after learning a new verb were unable to generalize their learning to new actors compared to the three year olds who napped shortly after learning 24 hours later, but the explanation for this result was not perfectly clear. If sleep played a more protective role in generalization, the explanation could be that sleeping after learning helped the nap group maintain the ability to generalize, whereas the group that stayed awake essentially forgot how to generalize. Conversely, if sleep played a more active role in generalization, the explanation could be that sleeping after learning actually improved the nap group’s ability to generalize, whereas the group that stayed awake simply maintained an inability to generalize. Since the mean generalization scores immediately after learning in Experiment 1 of the present study were essentially at chance, we can conclude that three year olds cannot generalize verbs to new actors immediately after learning them. Thus the wake group in Sandoval and Gómez did not forget how to generalize but rather never reached that point in the first place, and sleep played an active, rather than a protective, role in the generalization of the nap group.

Given the result that sleep does play an active role in generalization, Experiment 2 of the present study sought to discover at what point in the progression of nap and nighttime sleep that effect emerges, and specifically to see if the nap alone is enough to promote generalization. The results of the 4.5 hour condition were not significantly above chance, but they did approach significance, and seemed to create a trend toward the 24 hour nap group data reported by Sandoval and Gómez. This result can be interpreted in a few ways. If there is in fact an upward trend, one possibility is that the nap alone is not quite enough for a significant effect on generalization, but rather the combination of the nap with nighttime sleep is necessary for the
improvement in generalization. The second possibility is that, since the results of the 4.5 hour do approach significance, a larger sample would have moved the mean generalization score closer to that of the 24 hour condition in Sandoval and Gómez. If this is the case, then it is still possible that a nap alone is enough to promote generalization. In either case, the results may have interesting implications for our understanding of the sleep architecture of young children, as they suggest that something may be going on during a nap that makes it fundamentally different from a night’s sleep. Kurdziel et al. (2014) has already touched on this possibility, suggesting that preschoolers’ naps include an inordinately high proportion of slow wave sleep relative to REM sleep. Thus a promising direction for future study would be to include an element of polysomnography to the paradigm so as to better understand the stages of sleep that influence verb-generalization in three year olds. Likewise, future studies may want to investigate how individual differences play into verb-generalization, since certain participants in each condition including the immediate test received a generalization score of 75% or 100%, while others in each condition scored as low as 25%. This line of questioning could also benefit from a PSG study, as it is possible that these individual differences are related to differences in sleep quality.

The main limitations in this study, and thus considerations for future studies, were the use of a dichotomous test and a between subjects design. A dichotomous test was the best option for this study simply because most other possible tasks would likely be too difficult for this age group, but if future studies can find an equally simple alternative, a non-dichotomous test might better lend itself to analysis because it would eliminate the floor effect of a chance score. A between subjects design was also necessary, mainly because of concerns about testing effects, but a within-subjects alternative would be useful for investigating the individual differences mentioned above. Testing the same child at different points in the progression of sleep and wake
might eliminate much of the variation of the experiment and thus better isolate the effect to the role of sleep or wake and not external variables.

The practical applications of this study mostly pertain to the question of the necessity of napping for three year olds. Some states have lately sought to diminish or eliminate naptime curricula in preschools in favor of optional shorter “quiet times” (Warner 2014). The present study, however, suggests that naps play a very real and crucial role in preschoolers’ ability to extend their learning. While policymakers and administrators may argue that naptime takes up valuable class time which could be better used for learning, our research shows that learning goes far beyond the classroom experience, and can hopefully be used to encourage in young children a lifestyle which is both as healthy and as beneficial to learning as possible.
References


