REPRODUCED REPORT: REM sleep in naps differentially relates to memory consolidation in typical preschoolers and children with Down syndrome.

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Author Note

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Abstract

Naps are beneficial for learning in typically developing infants, children, and adults. They show greater retention when a delay between training and test contains sleep then when it is a comparable period of wake. However, individuals with Down syndrome have a high rate of disordered sleep than seen in the typical population. Do they experience the same benefits of sleep on learning? The current experiment suggests they do not. While typically developing preschoolers showed more retention after a period filled with sleep, children with Down syndrome had greater retention after a period of wakefulness.

Keywords: naps, sleep, memory, development, Down syndrome

Word count: X

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Methods

Participants

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Groups	N	Mean_age	PercentFemale
DS	25	9.49	52
TD	24	5.03	54

Materials & Procedure

The goal of this study was to assess the retention of new words with various intervals between training and test. Children received all conditions 1-2 weeks apart. The conditions included: 1. after a 5 min delay 2. after a nap (4 hour delay) 3. after 24 hours

Data analysis

The authors assessed the number of trials needed to reach criterion across conditions and groups.

The first analysis conducted was a repeated measures ANOVA for both wake and nap conditions. The second was a 2x2 ANOVA with delay type as the repeated factor and TD or DS as the between. These were conducted for the 4 and 24 hour delay.

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We used R (Version 3.5.2; R Core Team, 2018) and the R-packages *data.table* (Version 1.12.0; Dowle & Srinivasan, 2019), *dplyr* (Version 0.8.0.1; Wickham, François, Henry, & Müller, 2019), *ggplot2* (Version 3.1.0; Wickham, 2016), *papaja* (Version 0.1.0.9842; Aust &

Barth, 2018), *readxl* (Version 1.3.1; Wickham & Bryan, 2019), and *xtable* (Version 1.8.3; Dahl, Scott, Roosen, Magnusson, & Swinton, 2018) for all our analyses.

Results

Grouping	Timing	meanNTC	SEMNTC
DS	Immediate	1.680000	0.2628054
DS	Sleep	1.640000	0.1620699
DS	Wake	2.080000	0.1993322
TD	Immediate	2.041667	0.2789679
TD	Sleep	1.708333	0.1408973
TD	Wake	1.666667	0.2055980

[1] “factor”

Error: Subjects Df Sum Sq Mean Sq F value Pr(>F) Residuals 48 2.206 0.04596

Error: Subjects:Condition Df Sum Sq Mean Sq F value Pr(>F) Condition 1 0.007 0.00686 0.049 0.825 Residuals 48 6.674 0.13904

Error: Subjects Df Sum Sq Mean Sq GroupPerHr 1 0.151 0.151

Error: Subjects:CondPerHr Df Sum Sq Mean Sq CondPerHr 1 0.4689 0.4689

Error: Within Df Sum Sq Mean Sq F value Pr(>F)

GroupPerHr 1 0.164 0.1641 2.329 0.129

CondPerHr 1 2.349 2.3488 33.348 3.10e-08 ***GroupPerHr:CondPerHr 1 1.481 1.4813 21.032 8.18e-06*** Residuals 190 13.382 0.0704

— Signif. codes: 0 “***’ 0.001 ’’ 0.01*** ’” 0.05 “.” 0.1 “” 1

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Error: Subjects:CondPerHr Df Sum Sq Mean Sq CondPerHr 1 1.582 1.582

Error: Within Df Sum Sq Mean Sq F value Pr(>F)

GroupPerHr 1 0.594 0.594 8.552 0.00387 ** CondPerHr 1 5.653 5.653 81.333 < 2e-16 ***GroupPerHr:CondPerHr 1 5.362 5.362 77.155 9.23e-16*** Residuals 190 13.205 0.069

— Signif. codes: 0 “***’ 0.001 ’** *0.01 ’*” 0.05 “.” 0.1 “” 1

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Discussion

This study challenges the assumption that sleep is beneficial for learning across populations. Contrary to the pattern displayed by typically developing children, children with Down Syndrome showed improved performance during the wake condition as compared to the sleep condition.

References

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Table 1

ANOVA table for Experiment 1

Effect	F	df_1	df_2	MSE	p	$\hat{\eta}^2_G$
Condition	0.05	1	48	0.14	.825	.001

Table 2

ANOVA table for 4 hour delay

Effect	F	df_1	df_2	MSE	p	$\hat{\eta}^2_G$
GroupPerHr	8.55	1	190	0.07	.004	.043
CondPerHr	81.33	1	190	0.07	$< .001$	.300
GroupPerHr × CondPerHr	77.15	1	190	0.07	$< .001$	.289

Table 3

ANOVA table for 24 hour delay

Effect	F	df_1	df_2	MSE	p	$\hat{\eta}^2_G$
GroupPerHr	2.33	1	190	0.07	.129	.012
CondPerHr	33.35	1	190	0.07	$< .001$	.149
GroupPerHr × CondPerHr	21.03	1	190	0.07	$< .001$	.100

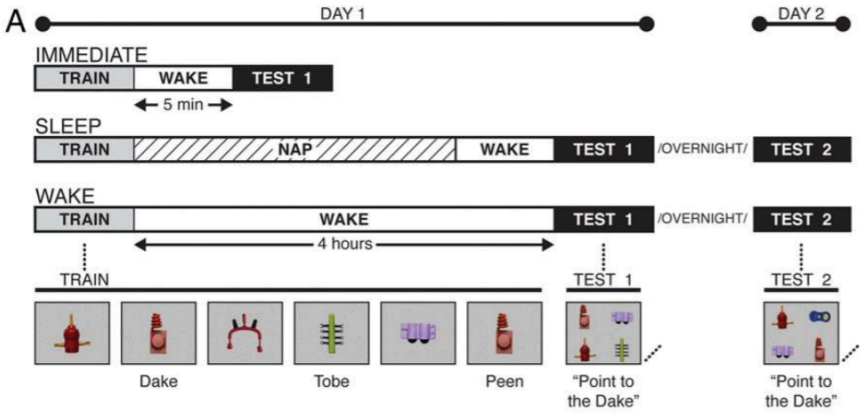

Figure 1. Methods

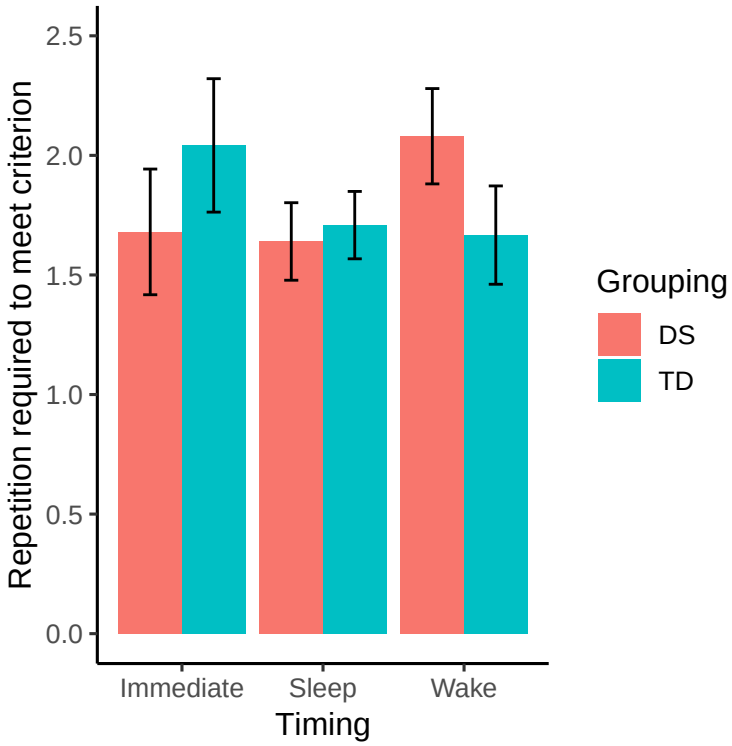

Figure 2. Average number of trials to criterion per group per condition.

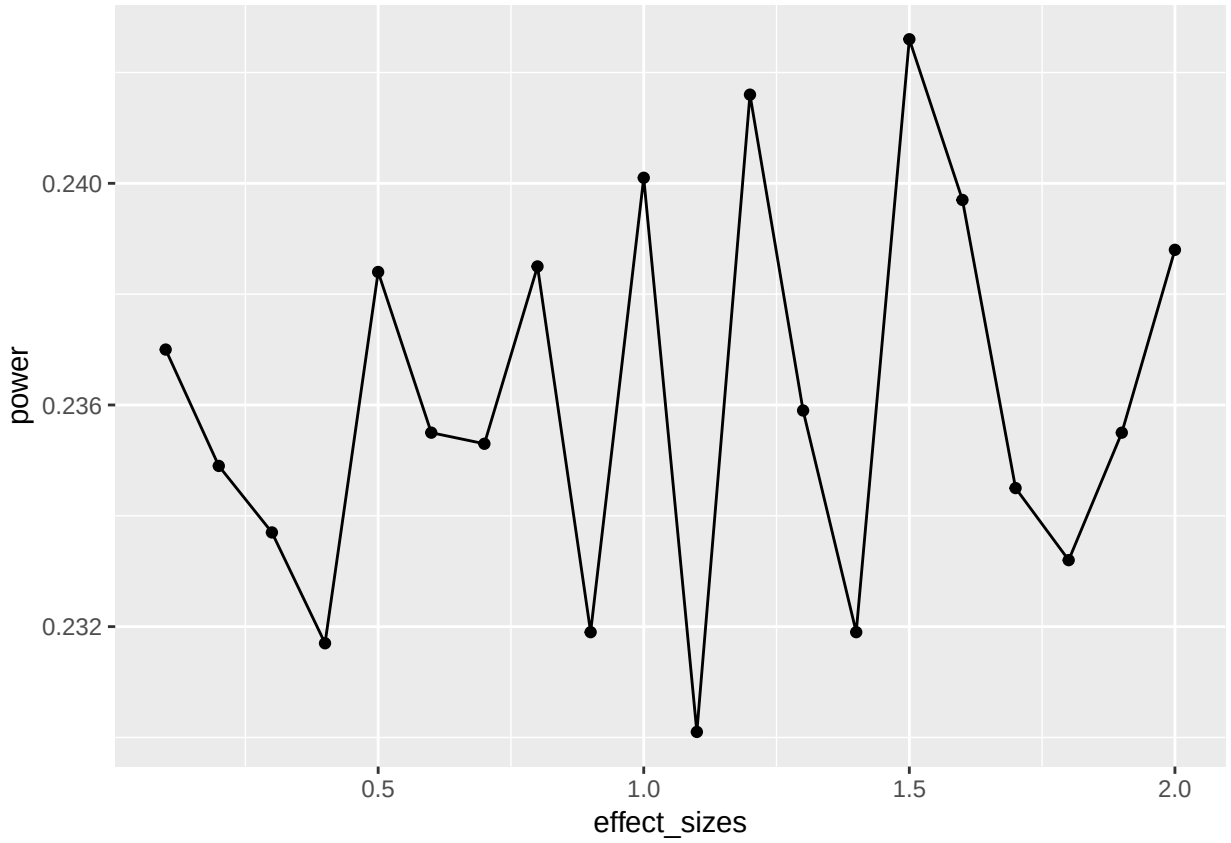

Figure 3

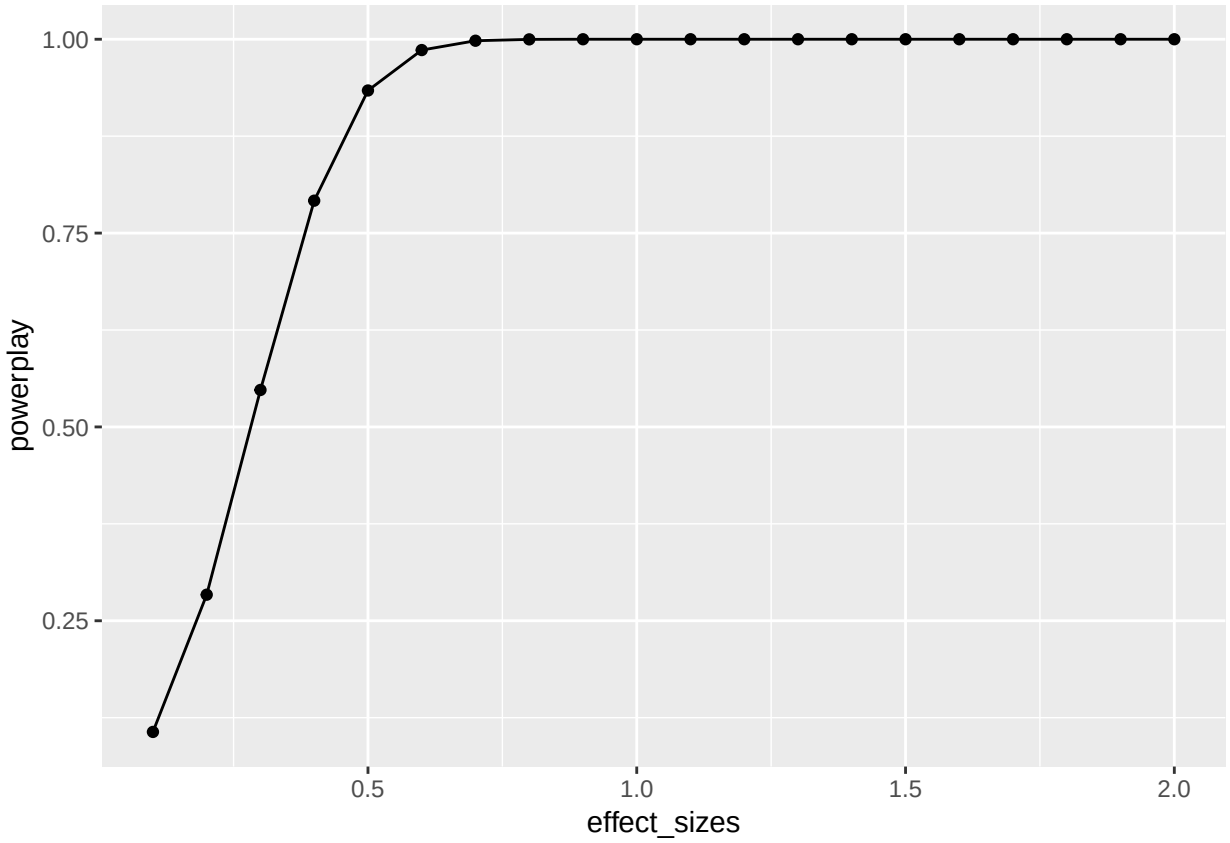

Figure 4