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Sleep Enhances Retention and Relearning Speed of Textual Information

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Introduction

- The effect of sleep on consolidation of newly learned information is well known (Rasch & Born, 2013). For declarative memories, many studies have shown better retention of verbal information when learning is followed by a period of sleep rather than an equivalent wake period (Plihal & Born, 1997 ; Gais et al., 2006 ; Schönauer et al., 2014).
- Most studies use simple experimental material (lists of word pairs, syllables, etc.). However, a recent research (Cousins et al., 2018) showed the beneficial effect of a nap on learning of factual knowledge, which is closer to school learning.
- Studies about spacing effect have shown that spaced sessions of learning and relearning leads to better long-term memorization than massed sessions (Cepeda et al., 2006). A period of sleep between learning sessions could optimize learning and long-term retention.
- A study (Mazza et al., 2016) showed that a sleep period between initial learning and relearning provides better post-learning retention, faster relearning of forgotten information and better long-term memorization.

- In the present study, **3 experiments** were conducted to determine whether this effect on relearning could be **generalized to factual knowledge**.
- In addition, if this effect is observed, is it different depending on the type of information learned? **Three kinds of informations** were tested in these experiments : **words (W), numbers (N) or pseudo-words (PW)**



Methodology

Material :

- Computerized procedure
- E1** : 1 text describing an imaginary animal and its way of life + 25 questions (9 words, 10 numbers, 6 pseudo-words)
- E2** : 1 text describing an imaginary historical event + 17 questions (3 words, 4 numbers, 10 pseudo-words)
- E3** : same text as in E2 with more details + 21 questions (4 words, 6 numbers, 11 pseudo-words)

Participants :

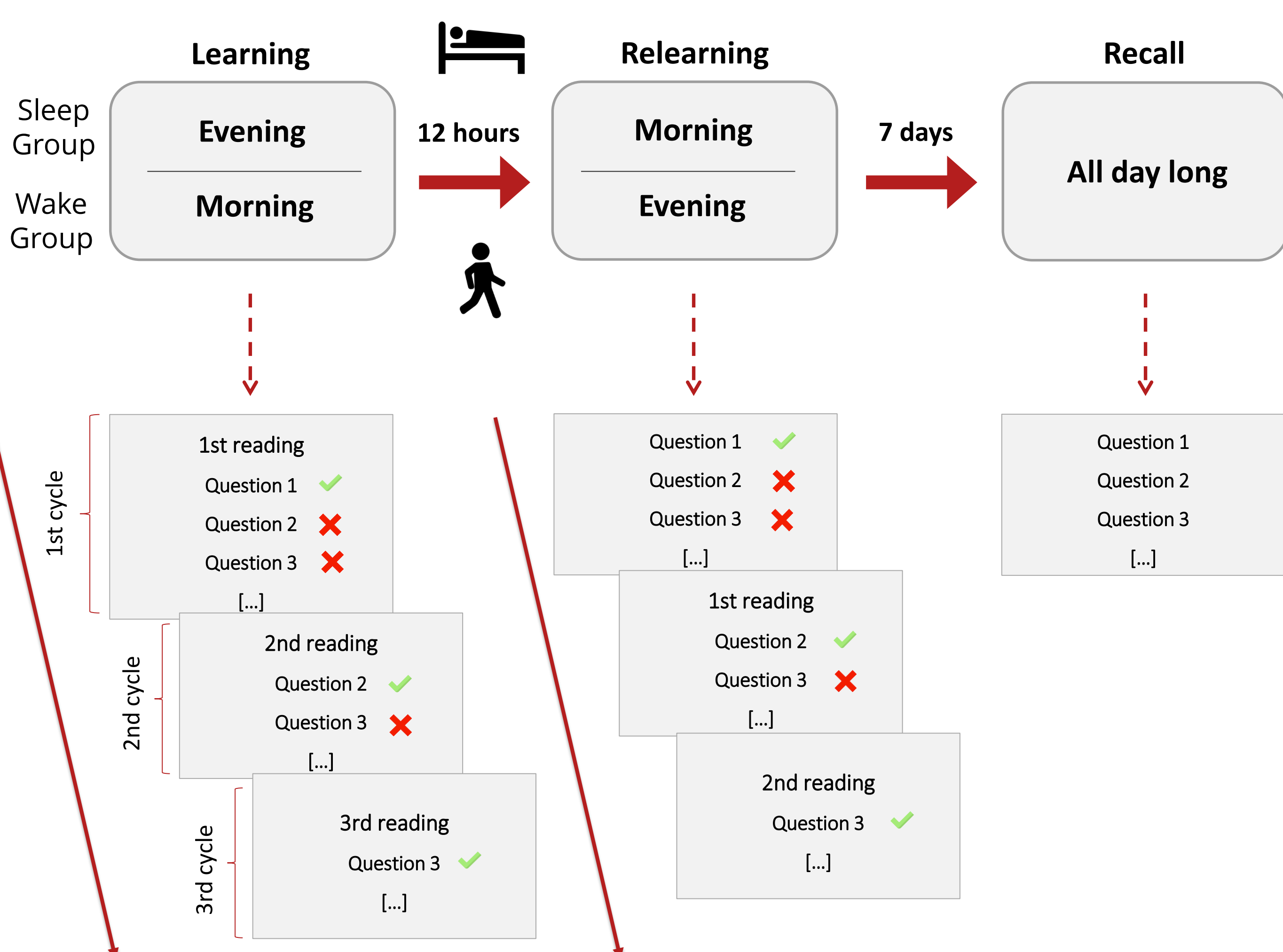
- Young adults aged 18 to 30 years (E1 : N = 30 ; E2 : N = 38 ; E3 : N = 34)
- 2 experimental groups (Sleep vs Wake)

Learning criterion :

- 1 correct answer per question
- Each question answered correctly is no longer presented

Main measures :

- Number of correct answers at first cycle of each session
- Number of trials needed to reach the learning criterion



Results

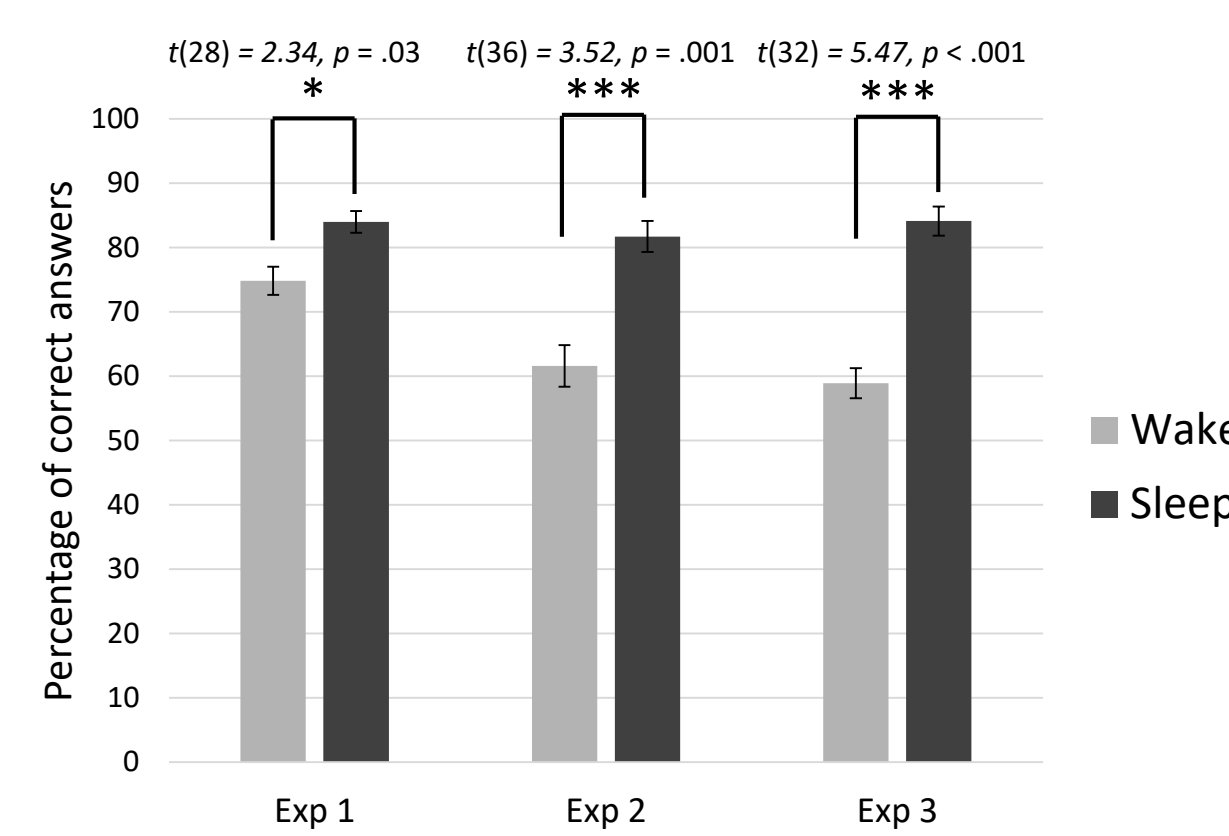


Fig. 1 Percentage of correct answers given at first cycle of relearning in each experiment for Wake and Sleep groups

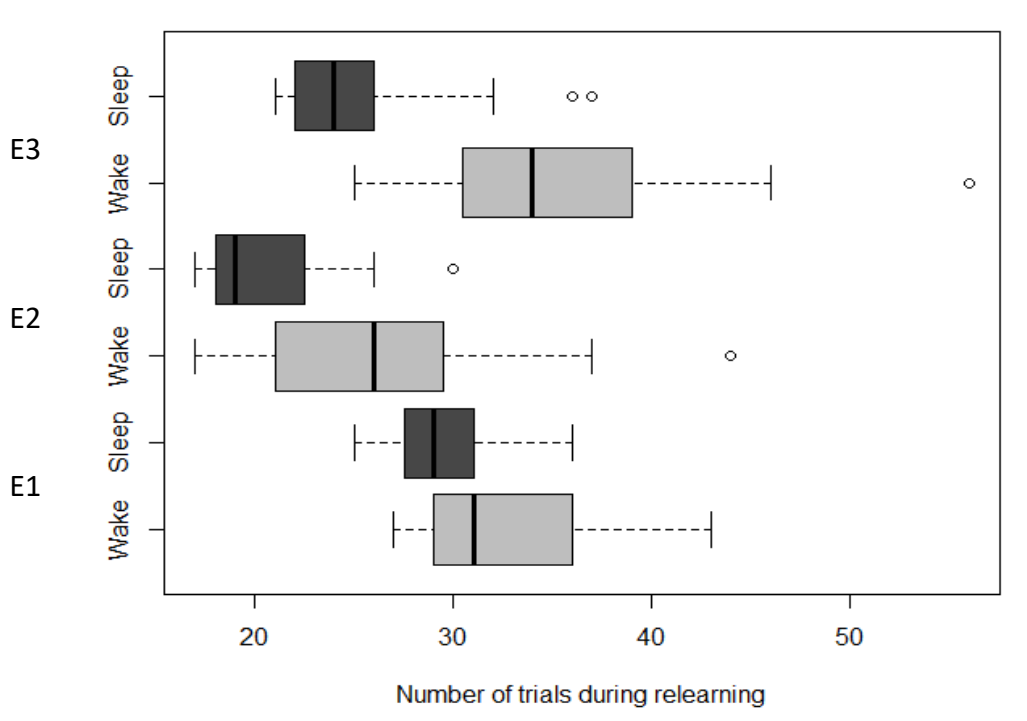


Fig. 2 Number of trials to reach the learning criterion at relearning (= total number of questions asked) in each experiment for Wake and Sleep groups

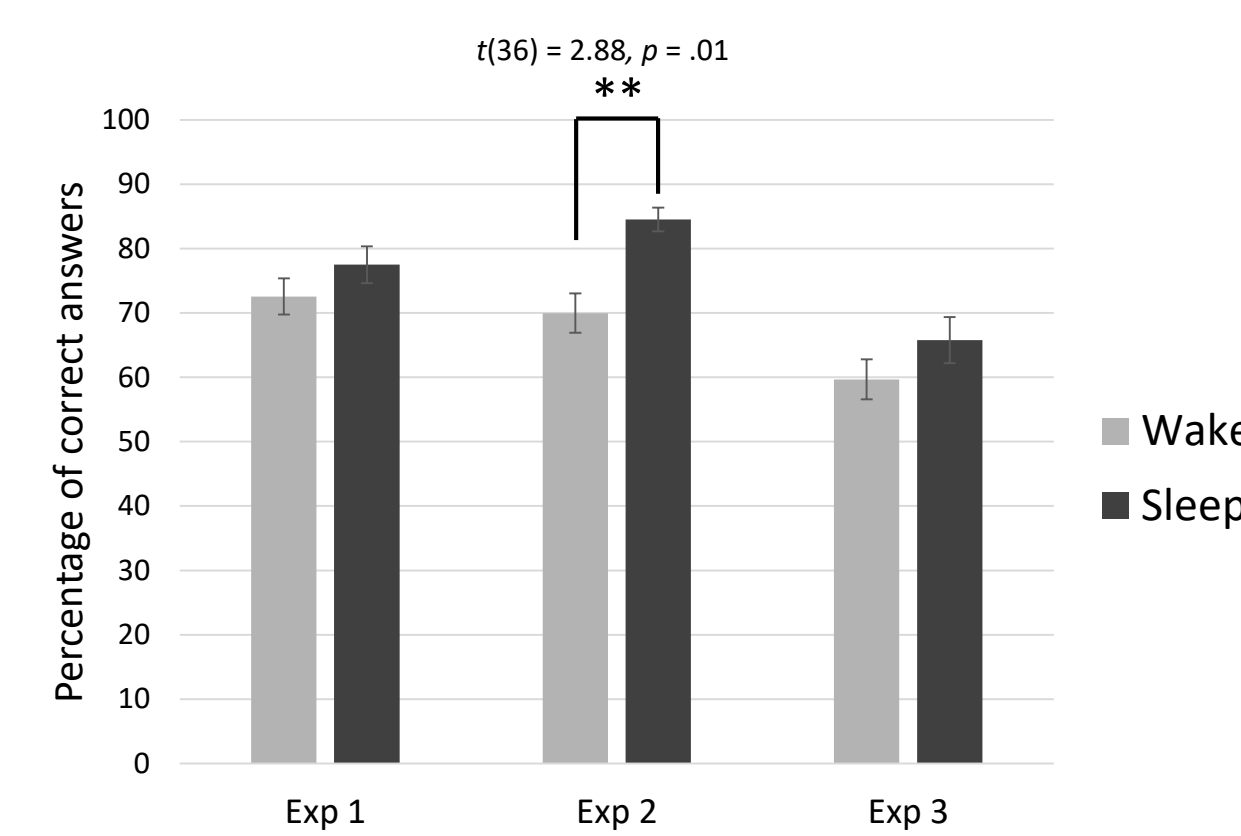


Fig. 3 Percentage of correct answers given during 7-day recall session for Wake and Sleep groups

- All 3 experiments showed a significant effect of sleep on retention before relearning
- All 3 experiments showed a faster relearning speed for the Sleep groups
- Only E2 showed a significant effect of sleep on the long term retention (7 days)

Item Analysis			
	No. of correct answers at first cycle of relearning	No. of trials at relearning	7-day recall
E1	W : ceiling effect	W : not signif. (p = .28)	Data not available
	N : signif. For sleep group (p = .01)	N : signif. For sleep group (p = .02)	
	PW : trend for sleep group (p = .07)	PW : trend for sleep group (p = .04)	
E2	W : ceiling effect	W : not signif. (p = .18)	Data not available
	N : not signif. (p = .39)	N : not signif. (p = .32)	
	PW : signif. for sleep group (p < .001)	PW : signif. for sleep group (p < .001)	
E3	W : not signif. (p = .29)	W : not signif. (p = .16)	W : not signif. (p = .33)
	N : not signif. (p = .14)	N : not signif. (p = .16)	N : not signif. (p = .32)
	PW : signif. for sleep group (p < .001)	PW : signif. for sleep group (p < .001)	PW : trend for sleep group (p = .08)



Conclusion

- Better retention of information after a night of sleep than a period of wakefulness**
 - The benefit of nocturnal sleep on consolidation seems to be generalizable to factual knowledge
- Faster relearning speed after a night of sleep than a period of wakefulness**
 - It seems that sleep facilitates the relearning of forgotten information
 - Possible link with the synaptic homeostasis hypothesis (Tononi & Cirelli, 2006) : desaturating the synapses during sleep would make it easier to create new memory traces during relearning and/or reuse recent ones
- Mixed results on the long-term (7 days) retention of information after a night of sleep**
 - Only one experiment (E2) showed better long-term retention for the Sleep group during the 7-day recall
 - Further studies are needed to confirm or disprove a long term sleep benefit
- Differential effect according to item type**
 - The results support a preferential sleep effect for the consolidation of pseudo-words information, which require the creation of new mental representations
 - Further studies are needed to understand whether these results are really due to the specific item type or to the ceiling effect observed for words and numbers



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