

# Language learning can withstand one night of total sleep deprivation

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## 01 INTRODUCTION

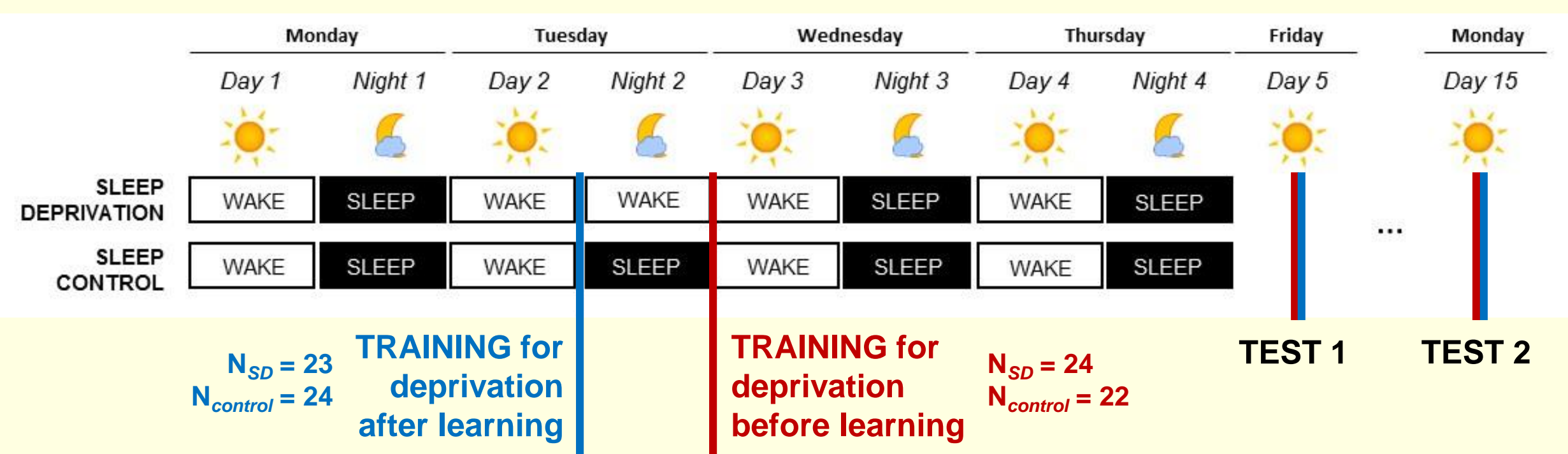
Generalisation, the ability to extract general knowledge from individual experiences, is at the heart of human learning.

This is particularly evident in learning to read: we extract general information about the relationship between letters and sounds by learning to read a large number of individual words.

We seek to better understand what role sleep plays in learning to read in a new artificial script, and how sleep may help extract general knowledge about the letter-sound relationships.

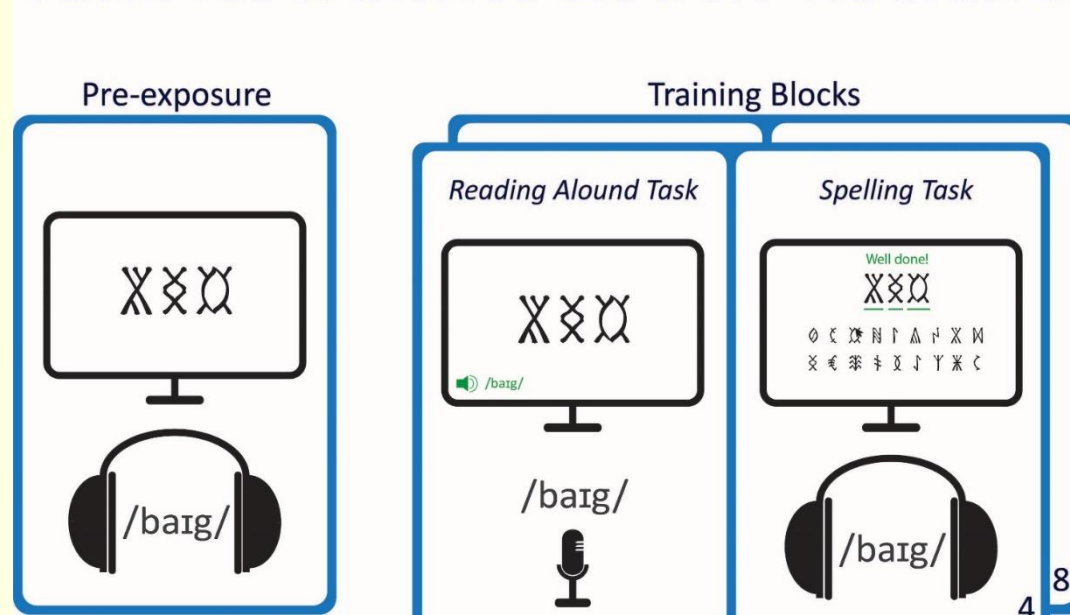
- Does sleep deprivation **before** learning impair participants' ability to extract and use the underlying letter-sound knowledge?
- Does sleep deprivation **after** learning impair participants' ability to extract and use the underlying letter-sound knowledge?

## 02 EXPERIMENTAL DESIGN



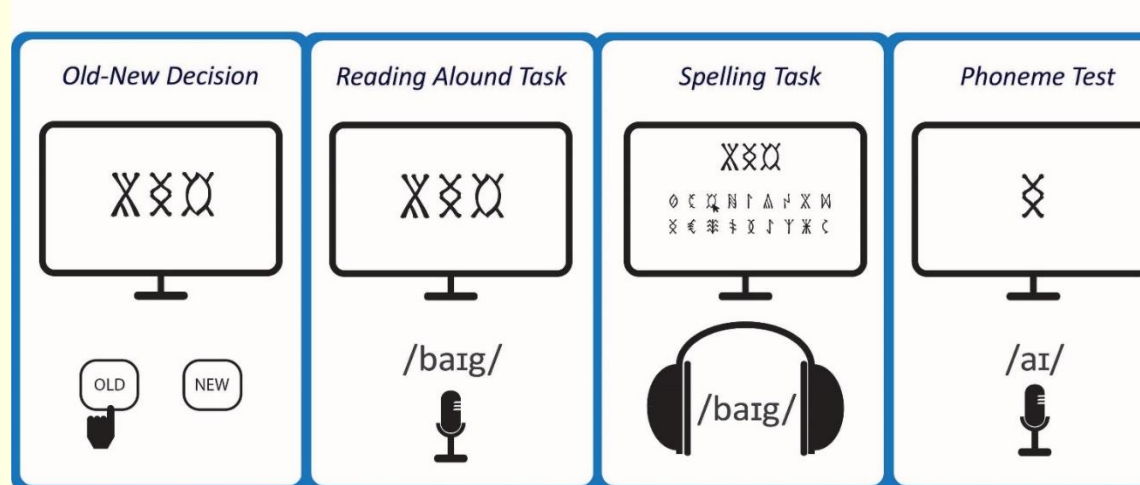
## 03 TRAINING AND TEST TASKS

### ARTIFICIAL ORTHOGRAPHY TRAINING



Participants had to reach a criterion of at least 70% correct in the spelling task.

### ARTIFICIAL ORTHOGRAPHY TESTING TASKS



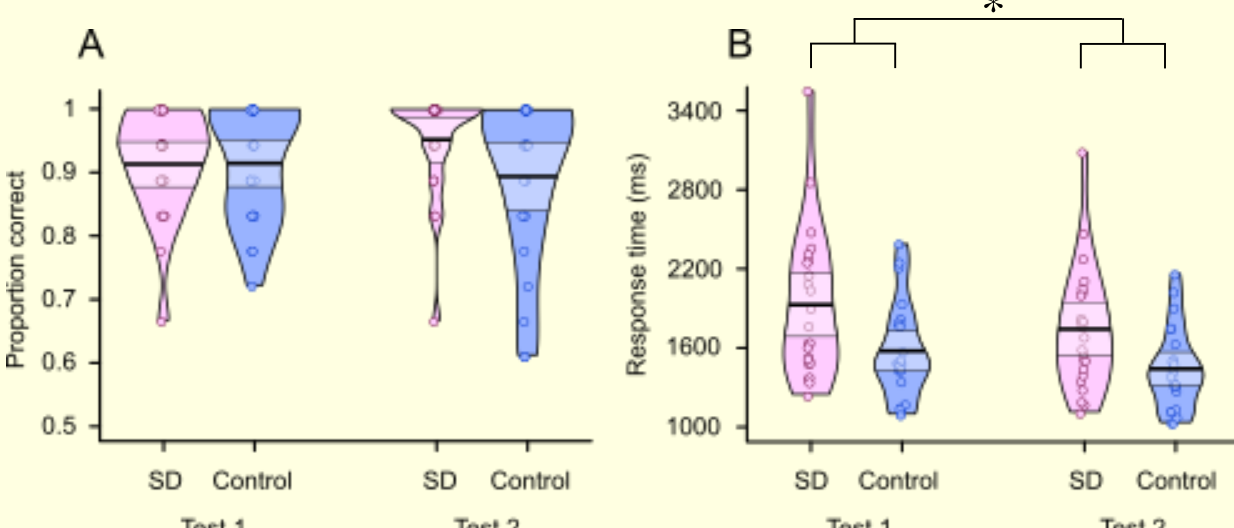
Test stimuli included **trained words** (tests episodic memory) and **untrained novel words** (tests generalisation).

Both accuracy and reaction time (RT) measured in all test tasks.

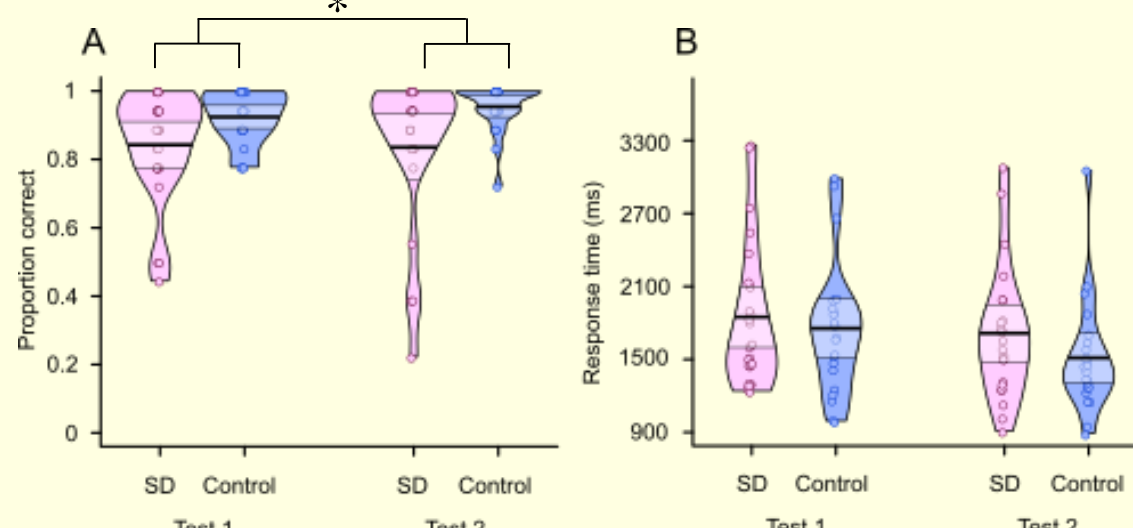
## 04 RESULTS

### Phoneme test

#### Deprivation after learning



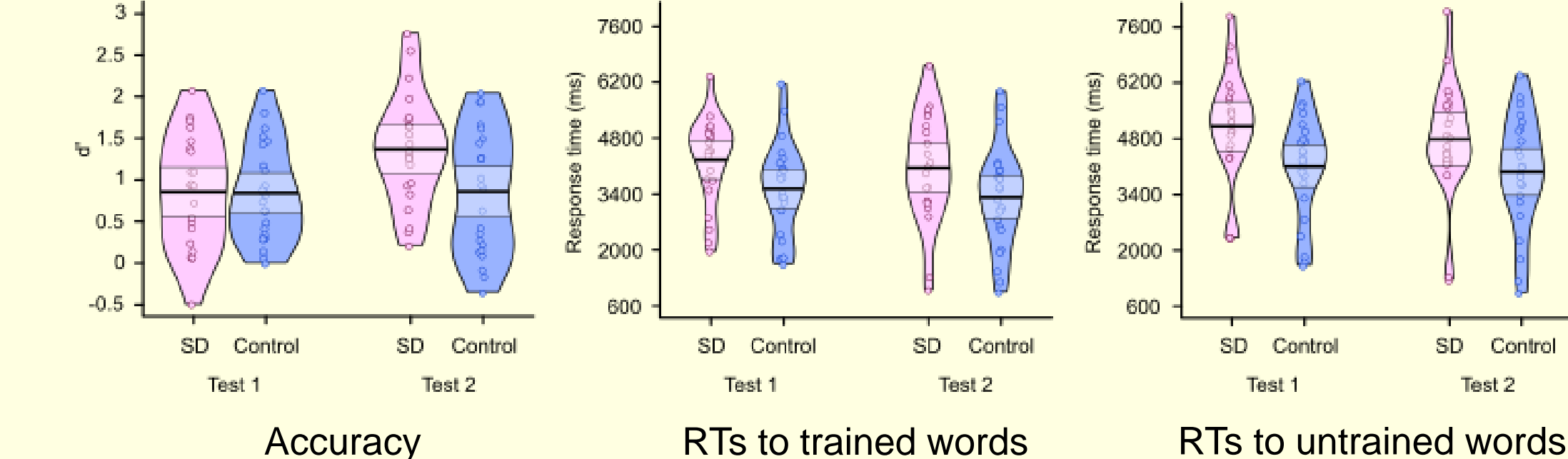
#### Deprivation before learning



Main effect of sleep deprivation in deprivation after learning RTs, and in deprivation before learning in accuracy.

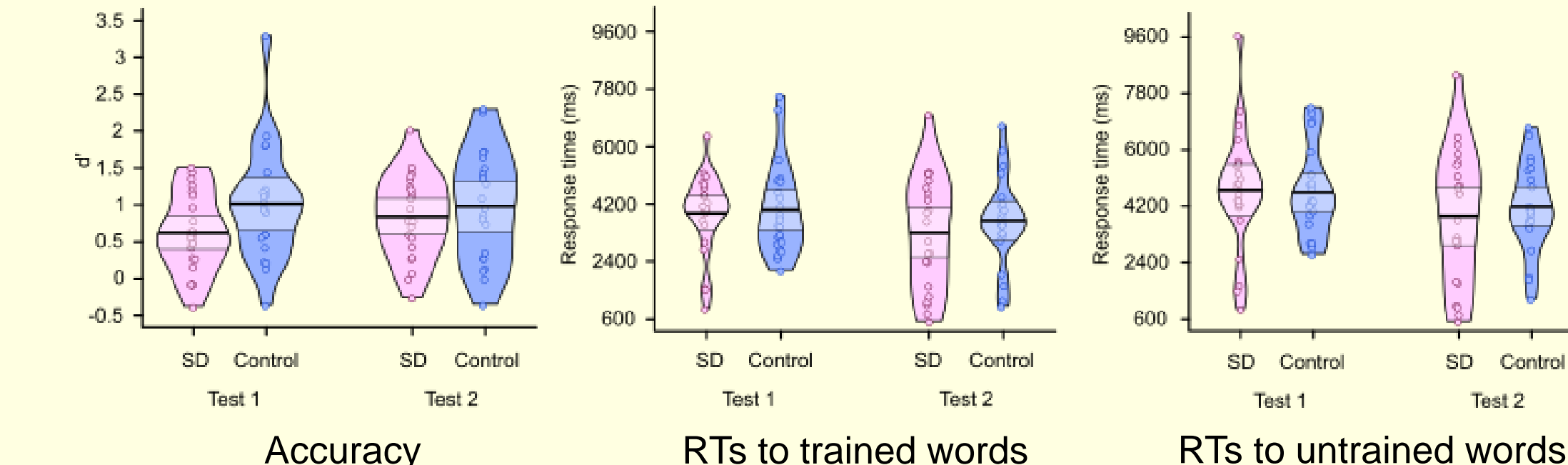
### Old-New decision

#### Deprivation after learning



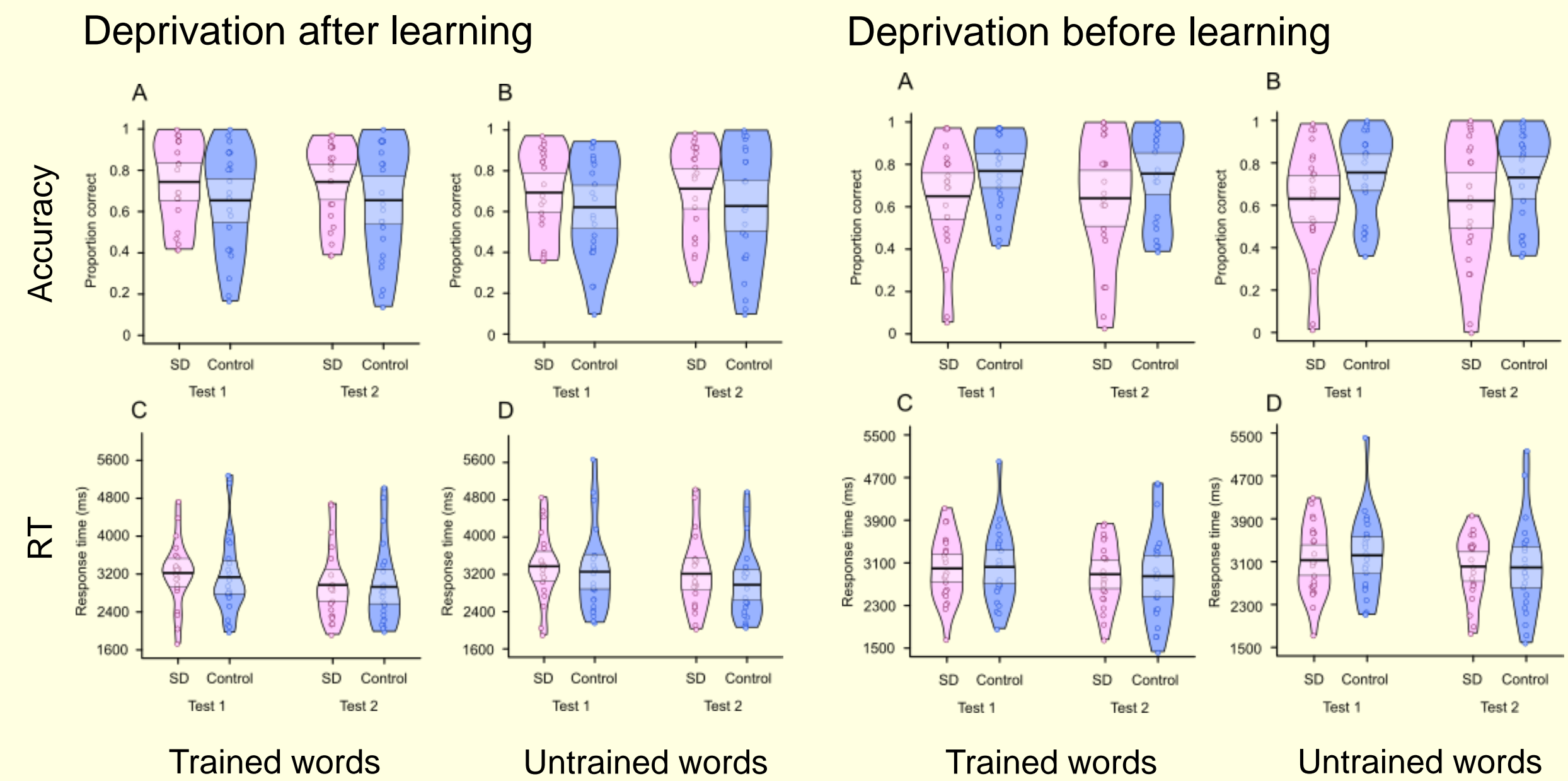
No effect of sleep deprivation.

#### Deprivation before learning



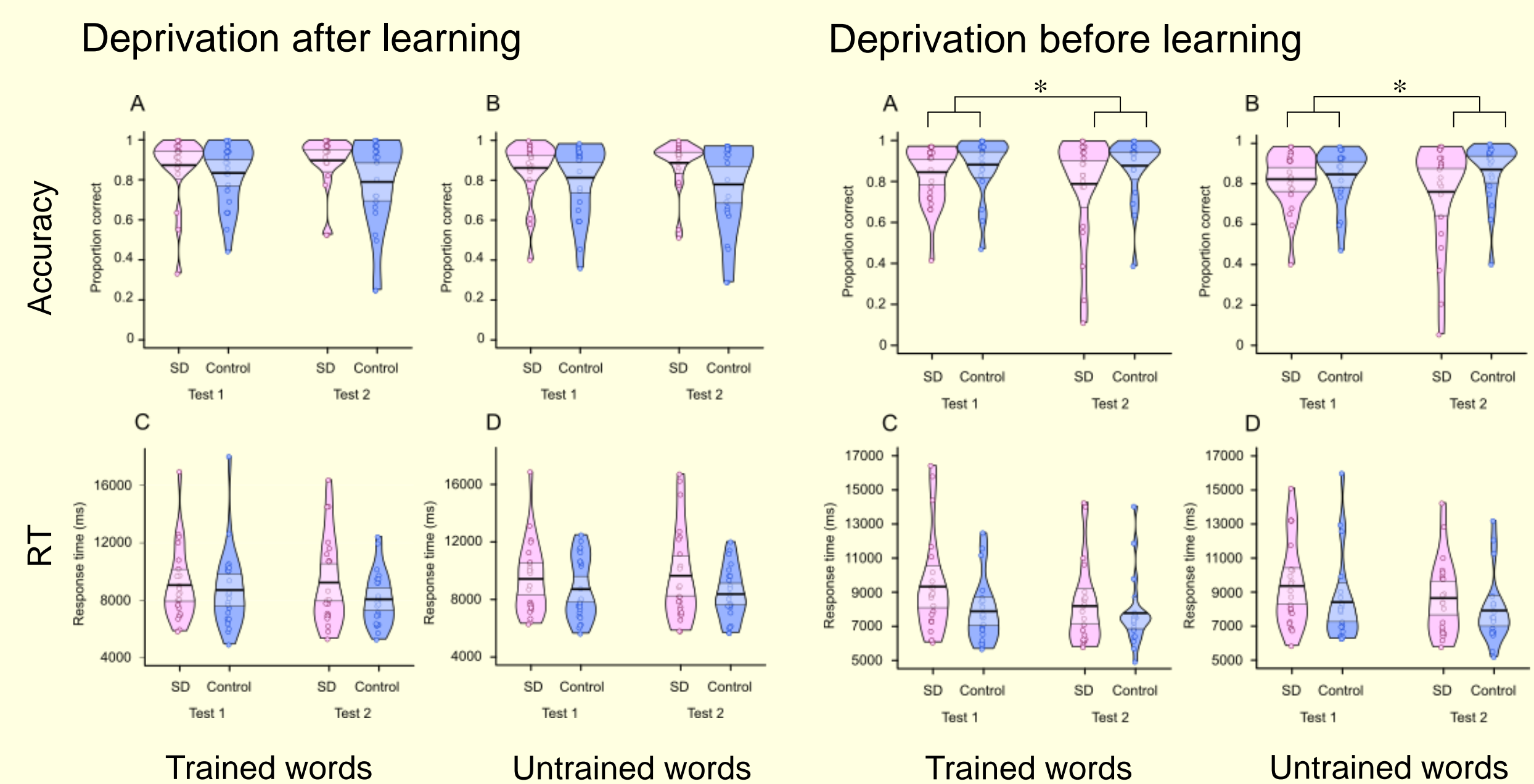
No effect of sleep deprivation.

### Reading aloud trained and untrained words



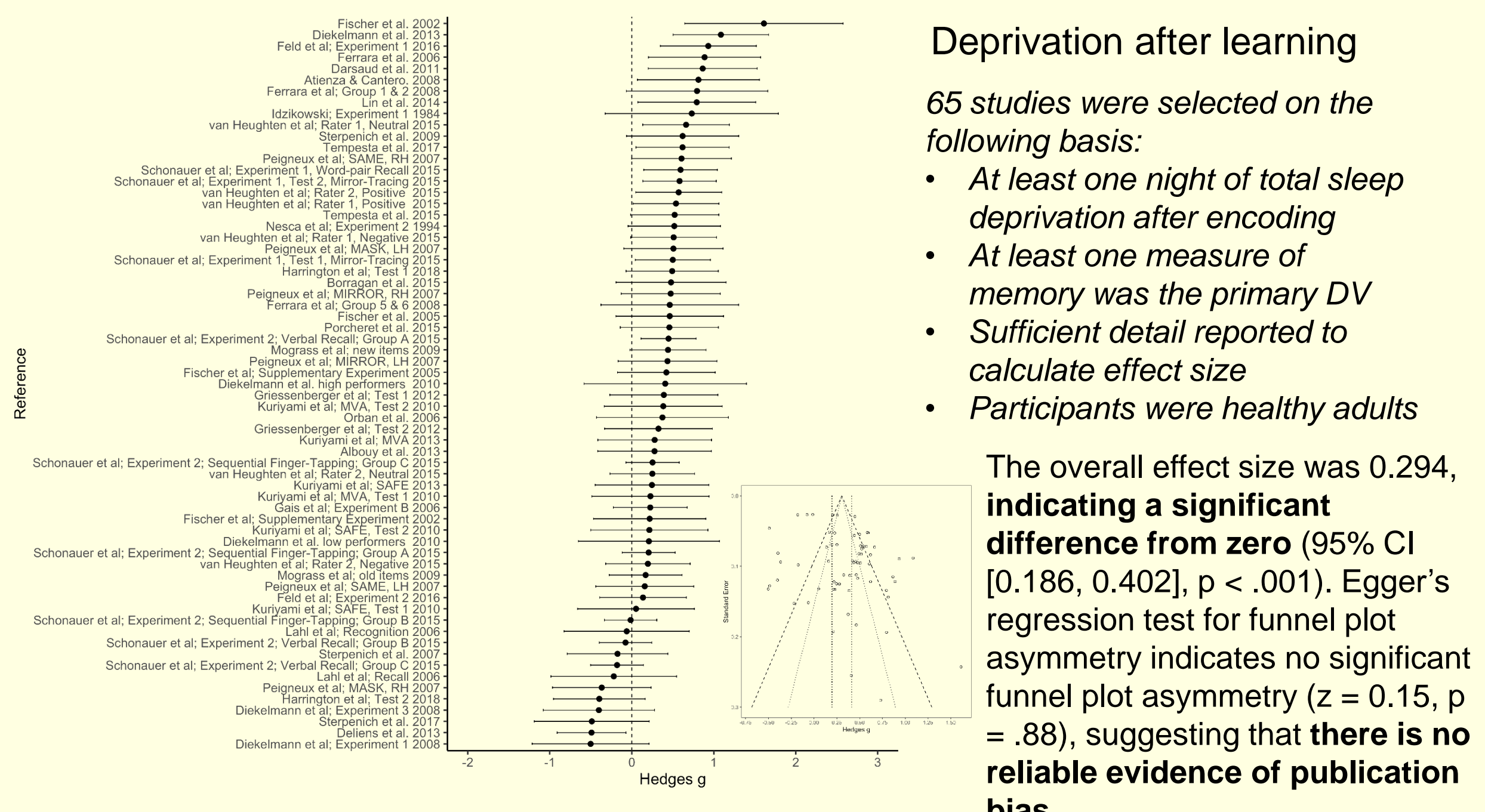
No effect of sleep deprivation.

### Spelling trained and untrained words



No effect of sleep deprivation in deprivation after learning, but in deprivation before learning controls were significantly more accurate.

## 05 META-ANALYSIS OF SLEEP DEPRIVATION EFFECTS ON MEMORY



### Deprivation before learning

40 studies were selected on the same basis as above.

The overall effect size was 0.632, indicating a significant difference from zero (95% CI [0.471, 0.792],  $p < .001$ ). Egger's regression test for funnel plot asymmetry indicates significant funnel plot asymmetry ( $z = 4.09$ ,  $p = .001$ ), suggesting that there may be some publication bias.

Taking potential publication bias into account, a trim-and-fill analysis still showed a significant difference from zero though,  $g = 0.452$ ,  $p < .001$ .

## 06 SUMMARY & CONCLUSIONS

- We found little evidence that one night of total sleep deprivation before or after learning impairs learning or generalisation of a new writing system.
- Our meta-analysis suggests other forms of memory are impacted by sleep deprivation, and that this finding holds even when taking publication bias into account.