



The Cognitive Boost at the Peak of Circadian Arousal is Not as General as Previously Thought!

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Synchrony Effect

 Cognitive performance is assumed to be better at the peak of circadian arousal ("on peak") than at off peak (e.g., May & Hasher, 1993, Psychol Sci)

Chronotype	Peak of circadian arousal at	Better performance
Morning type	morning	in the morning than in the evening
Evening type	evening	in the evening than in the morning



Previous Research

Construct	Evidence <i>in favor of</i> the synchrony effect	Evidence <i>against</i> the synchrony effect
Working memory (= Ability to retain access to a limited amount of information)	 Rowe et al., 2009, Q J Exp Psychol Schmidt et al., 2015, Front Neurol West et al., 2002, J Gerontol B Psychol Sci Soc Sci 	 Ceglarek et al., 2021, <i>Chronobio Int</i> Heimola et al., 2021, <i>Sleep</i> <i>Advances</i> Lewandowska et al., 2018, <i>Chronobiol Int</i>
Attentional control (= Maintaining a goal and goal-relevant information when facing distraction; von Bastian et al., 2020, <i>PsyArXiv</i>)	 Hahn et al., 2012, <i>Dev Sci</i> Hasher et al., 2002, <i>Can J Exp</i> <i>Psychol</i> May & Hasher, 1998, <i>J Exp</i> <i>Psychol Gen</i> Manly et al., 2002, <i>Neuropsychologia</i> 	 Knight & Matter, 2013, <i>Exp</i> <i>Aging Res</i> Li et al., 1998, <i>Psychol Aging</i> Matchock & Mordkoff, 2008, <i>Exp Brain Res</i> Schmidt et al., 2012, <i>PLoS One</i>



- Most studies were underpowered (i.e., they included small sample sizes in between-subjects designs).
- Most studies included only one task, but the tasks differ across studies.
 - Working memory: unclear to what extent only short-term memory was assessed
 - Attentional control: missing convergent validity

(e.g., Karr et al., 2018, *Psychon Bull Rev*; Rey-Mermet et al., 2018, *J Exp Psychol Learn Mem Cogn*; Rey-Mermet et al., 2019, *J Exp Psychol Gen*; Rey-Mermet et al., 2020, *PLoS One;* Rey-Mermet et al., 2021, *PsyArXiv;* von Bastian et al., 2020, *PsyArXiv*)



The Goal of the Present Study was...

to test the synchrony effect in working-memory and attentional-control processes



Sample

• *Recruited sample*: 689 young participants from the general population

Exclusion criteria	Number
 Demographic and health criteria not aged between 18 and 28 no Swiss German or German as native language neurological or psychiatric disorders 	19
Missing data	115
No laboratory-like conditions	83
Multivariate outliers	26
Neither morning nor evening chronotype (according to D-MEQ; Griefahn et al., 2001, Somnologie)	255

• Final Sample: **191 young** participants $(M_{age} = 23.8, SD_{age} = 3.0, women = 135)$



Experiment

- Online sessions at 8:00 and 17:00
 - \Rightarrow All participants were tested at **both on-peak** and **off-peak** times.
 - \Rightarrow Within-subject design
- 8 tasks:

Short-term memory (STM)	Working memory (WM)
Digit simple span	Numerical complex span
Letter simple span	Spatial complex span
Matrix simple span	Numerical updating
Arrow simple span	Spatial updating

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STM task: Digit Simple Span

<u>Task</u>:

- 1. to memorize three to nine digits
- 2. to recall the digits in correct serial order

Dependent measure:
 Accuracy rates
 for items recalled
 at the correct position





WM task: Numerical Complex Span



Attentional Control?

Residual variance from WM tasks



(e.g., Engle et al., 1999, J Exp Psychol Gen)

Attentional Control?

<u>Residual</u> variance from WM tasks <u>Common</u> variance across WM and STM tasks



(e.g., Engle et al., 1999, J Exp Psychol Gen)

(e.g., Kane et al., 2004, J Exp Psychol Gen)



Synchrony Effect at the Individual-Task Level



Error bars represent within-subject 95% confidence intervals (Cousineau, 2005, *Tutor Quant Methods Psychol*; Morey, 2008, *Tutor Quant Methods Psychol*)









Synchrony Effect at the Latent-Variable Level Attentional Control as a Common Construct



Multiverse Approach

Re-analyses with different...

- data transformations
- chronotype selections
- trimming procedures
- Structural equation modeling approaches



 \Rightarrow Similar results

Take-Home Message

- No general and robust synchrony effect
 - in STM and WM tasks
 - in short-term maintenance processes
 - in attentional-control processes
- ⇒ The present findings call into question the **necessity of assuming a** synchrony effect.



Thank you for your attention!

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