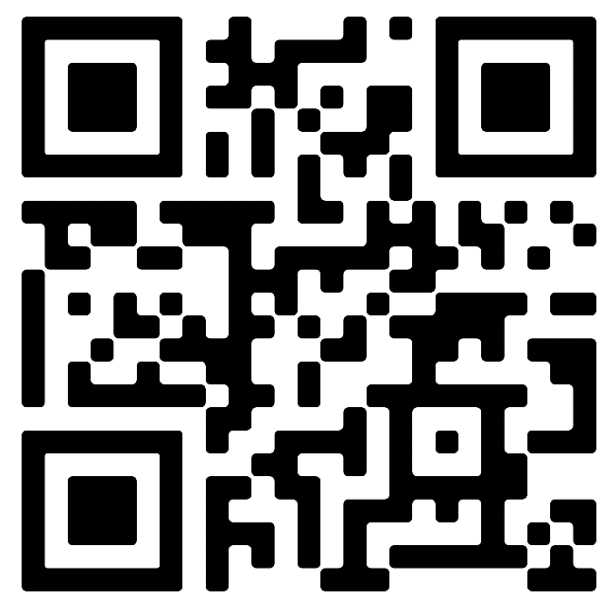


# Time of day and chronotype effects on children's intellectual capacity

Luís Pires<sup>1, 2, 3</sup>; Diana Couto<sup>4</sup>; Hugo Cruz<sup>5</sup>; Catarina Bettencourt<sup>1, 2</sup>; José A. Leitão<sup>1, 2</sup>; Maria H. Azevedo<sup>6</sup>; Daniel R. Marques<sup>2, 4</sup>; and Ana Allen Gomes<sup>1, 2</sup>

Scan to get access to the Reference list:



<sup>1</sup>Faculty of Psychology and Educational Sciences, University of Coimbra, Coimbra, Portugal;

<sup>2</sup>CINEICC - FCT R&D Unit: Centre for Research in Neuropsychology and Cognitive Behavioural Intervention, Coimbra, Portugal;

<sup>3</sup>Department of Psychology, School of Life Sciences, University of Hull, Hull, United Kingdom;

<sup>4</sup>Department of Education and Psychology, University of Aveiro, Aveiro, Portugal;

<sup>5</sup>Interdisciplinary Research Centre for Education and Development (CeIED), University of Lusófona, Lisbon, Portugal.

<sup>6</sup>Faculty of Medicine, University of Coimbra, Coimbra, Portugal



25th Congress of the European Sleep Research Society

22 – 24 September 2020

## Introduction

In school settings, children's IQ is assessed and used as a predictor of their learning capacity and academic achievement. Among the factors that may contribute to children's IQ' results are testing time and chronotype<sup>(1-3)</sup>. Chronotype refers to the individual differences that exist in the acrophases of several circadian rhythms (e.g., body temperature). It has been found that individuals may operate optimally or non-optimally at different times of the day based on their chronotype<sup>(4)</sup>. The present study aimed to probe potential Chronotype X Time of Day (ToD) interactive effects on children's IQ results.

## Methods

School children from 2<sup>nd</sup>, 3<sup>rd</sup>, and 4<sup>th</sup>-grades (N=68; 33 girls; 7-10 years old), either Morning (M-Types, n=34) or Evening-types (E-Types, n=34), were randomly assigned to assessment sessions in the first or the last hours of the school day – 9:00 am or 4:00 pm. Chronotype was defined using the 20<sup>th</sup> and 80<sup>th</sup> percentiles from morningness/eveningness scale score of the Children Chronotype Questionnaire – CCTQ<sup>(5)</sup>. All four groups, resulting from crossing Chronotype and ToD, were similar in terms of age, sex, educational grade, and sleep problems reported by parents. Intellectual function was assessed through the Wechsler Intelligence Scale for Children Third Edition (WISC-III) battery.

We examined the following dependent variables:

### IQ scores:

Full IQ  
Verbal IQ  
and Performance IQ

### Index scores:

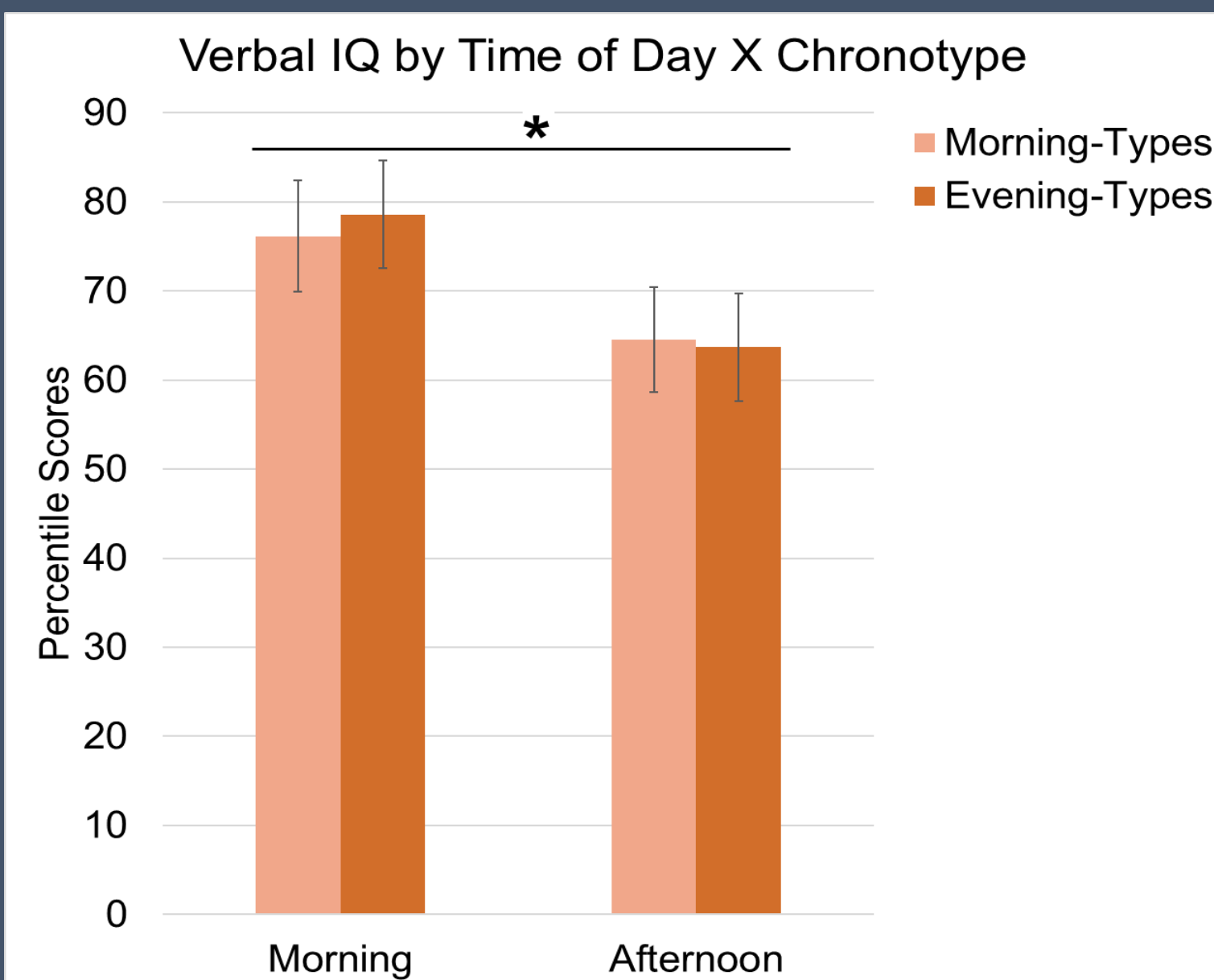
Verbal Comprehension Index (VCI)  
Perceptual Organization Index (POI)  
Freedom from Distractibility Index (FDI)  
and Processing Speed Index (PSI)

Age-based standardized scores for each of the WISC-III subtests:

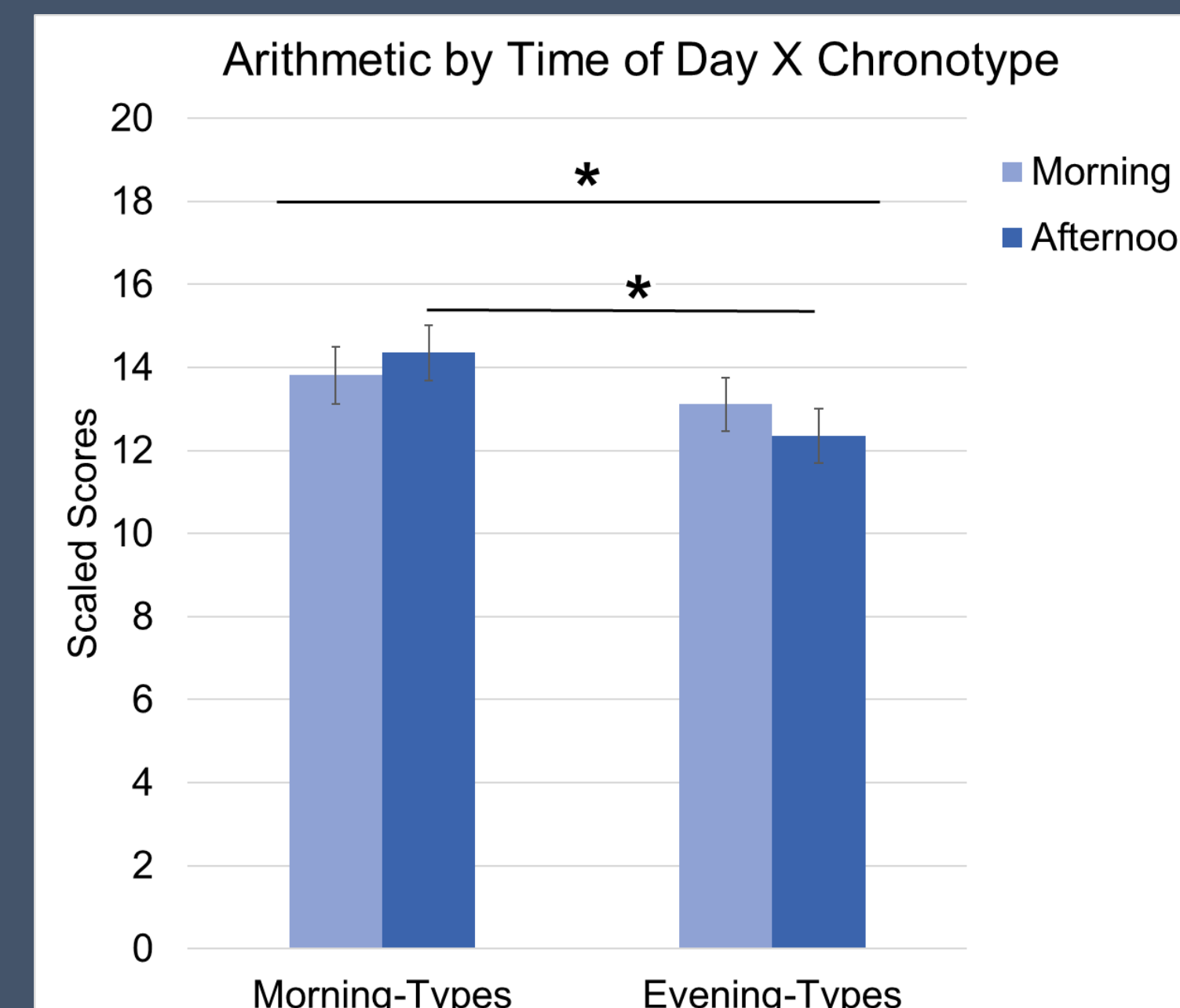
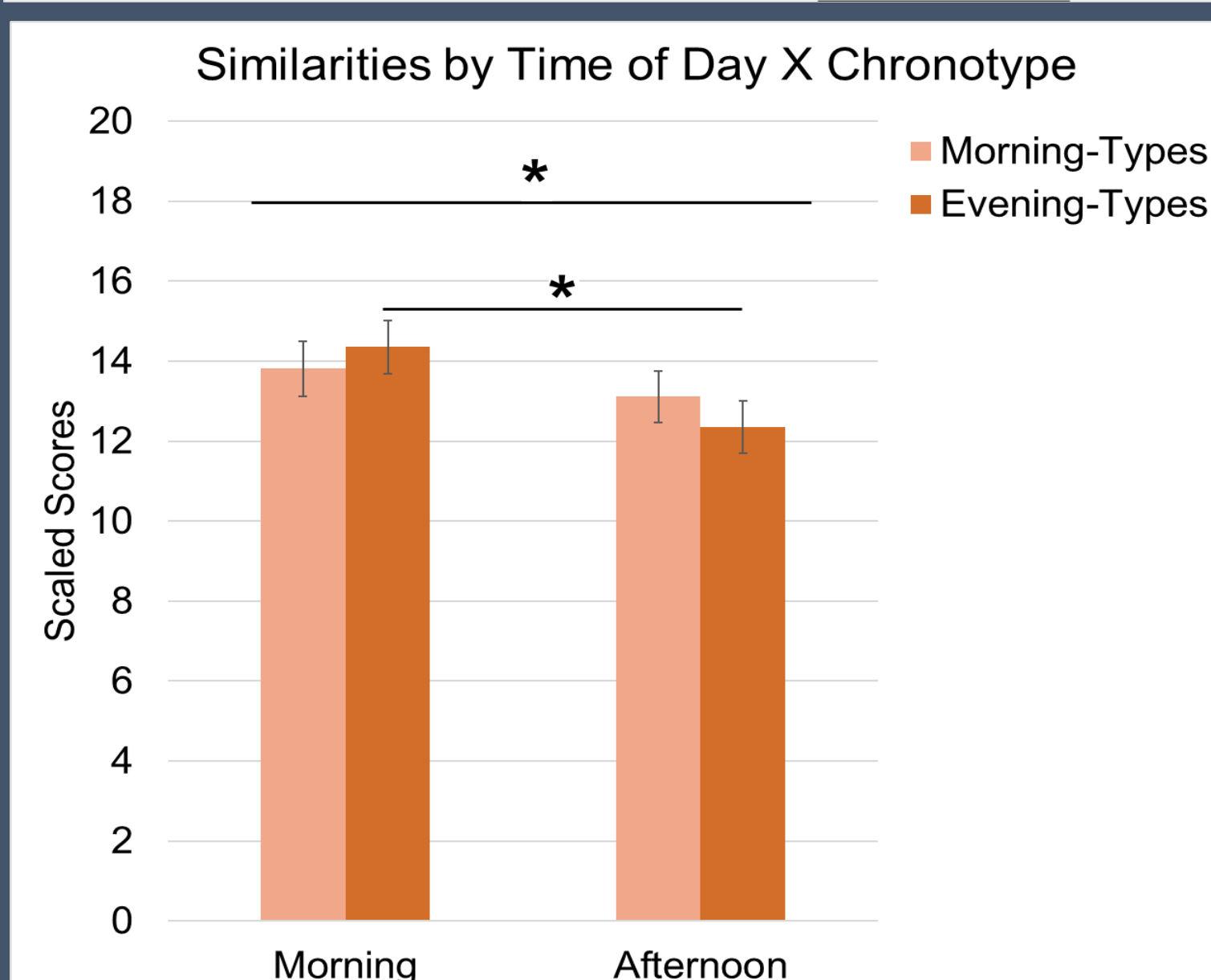
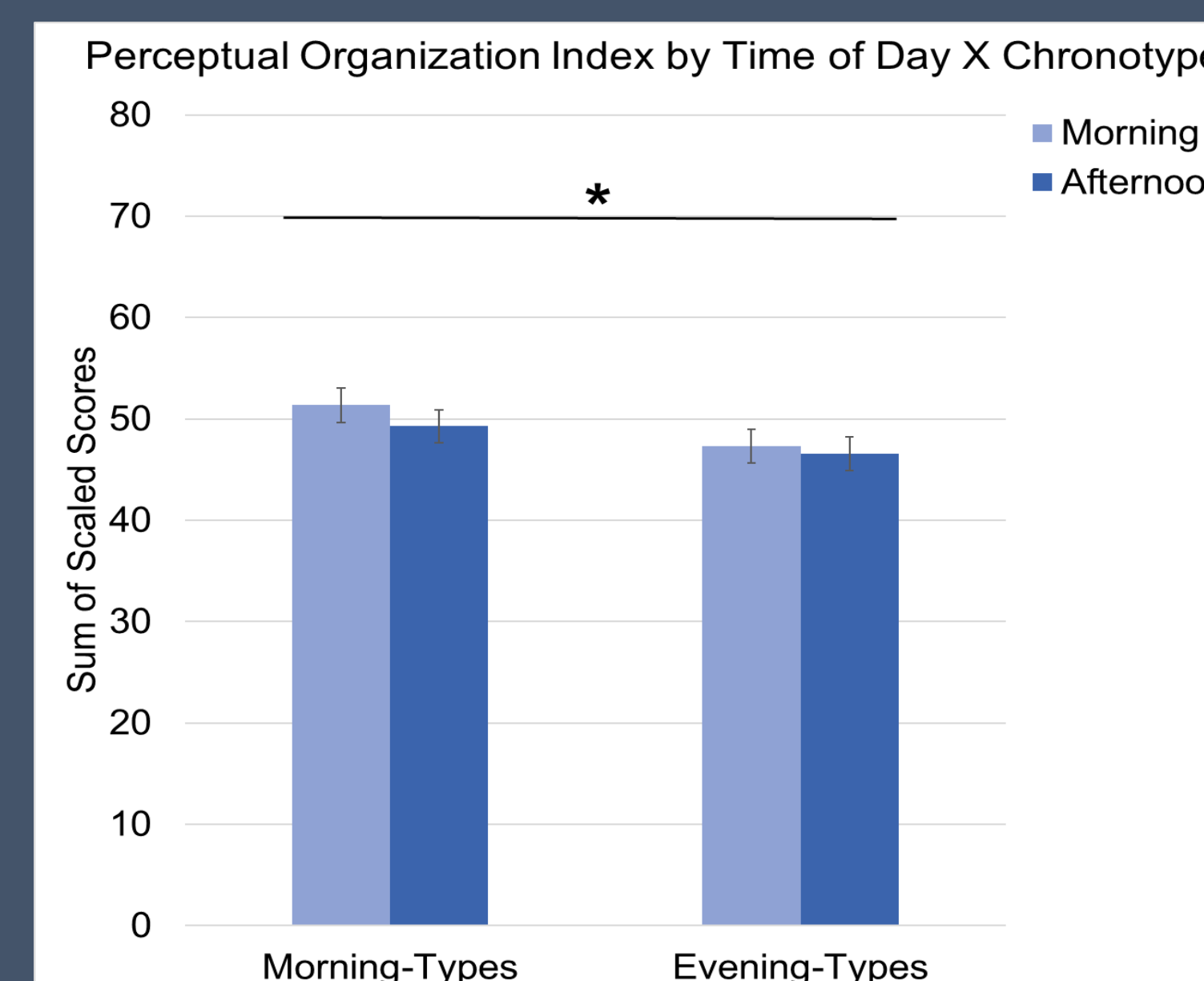
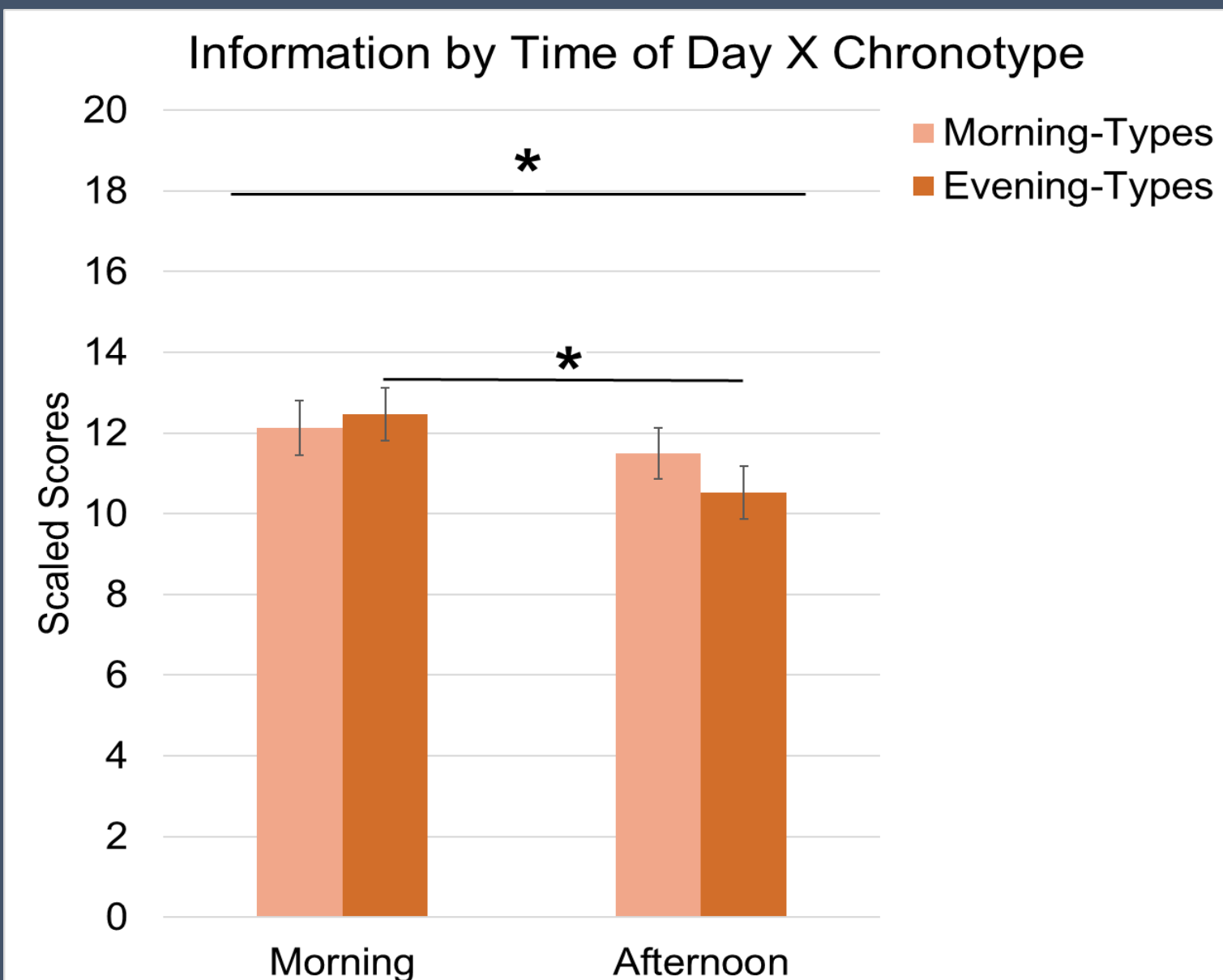
Picture Completion, Information, Coding, Similarities,  
Picture Arrangement, Arithmetic, Block Design, Vocabulary,  
Object Assembly, Comprehension, Symbol Search, Digit Span and Mazes

## Results

No effects of Chronotype X ToD were found in IQ, Indexes, and subtests scores. Still, main effects were uncovered. Concerning ToD, children assessed in the afternoon revealed lower verbal IQ percentile scores ( $p = .033$ ,  $\eta p^2 = .069$ ). On two verbal subtests, Information ( $p = .039$ ,  $\eta p^2 = .065$ ) and Similarities ( $p = .036$ ,  $\eta p^2 = .067$ ), a similar effect occurred only for E-types, with a worse performance in the afternoon.



In respect to Chronotype, M-types showed higher scores in the POI ( $p = .033$ ,  $\eta p^2 = .069$ ). On a verbal subtest, the Arithmetic subtest ( $p = .020$ ,  $\eta p^2 = .082$ ), a chronotype effect was detected, although only in the afternoon time, with E-types revealing a worse performance than M-Types.



## Discussion

Despite the absence of a Chronotype X ToD interaction, IQ scores of primary school children seem to vary according to these factors independently. Our sample's M-types revealed a better ability to interpret and organize visually-presented material (higher scores in the POI). Since previous studies suggest that morningness positively correlates with academic achievement<sup>(6,7)</sup>, M-types may exhibit better performance in tasks involving skills that are heavily trained in school, such as the ones involved in these WISC-III verbal measures. Concerning the worse performance of E-Types in the Arithmetic subtest only in the afternoon time, we can hypothesize that differences in other variables not accounted for our study, such as fatigue levels or motivation<sup>(6)</sup>, could partially explain this finding. In respect to ToD, our findings suggest that it may influence IQ verbal scores, resulting in lower scores for children assessed in the afternoon time. A similar ToD effect occurred on two verbal subtests, but just for E-types. Variables, like higher fatigue levels in the afternoon, especially in E-types children, could explain these ToD effects. A full understanding of how ToD affects intelligence in children is still lacking. Replication studies are needed.

## Conclusions

Results suggest that ToD influences primary school children's performance on Verbal IQ's tasks, seeming better to assess verbal tasks in the morning time. Concerning chronotype, M-type children of our sample seem to have a better ability to interpret and organize visually-presented material. However, no differences were found in most WISC-III scores between M-types and E-types, suggesting that this variable has little influence on IQ scores. It is important to emphasize that current results can not be generalized to other age groups (e.g., adolescents) due to differences in accumulation of homeostatic sleep pressure and in the circadian timing system.

## Acknowledgements

This work was developed under a larger research project [PTDC/PSI-EDD/120003/2010] funded by the Portuguese Foundation for Science and Technology (FCT) and FEDER/COMPETE/QREN. and it is currently supported by Project True Times - Research Grant PTDC/PSI-ESP/32581/2017|CENTRO-01-0145-FEDER-032581, funded by FEDER, PT2020, CENTRO2020, FCT.