

PRESENTING THE RESEARCH PROJECT "TRUE TIMES - MORNINGNESS-EVENINGNESS AND TIME-OF-DAY EFFECTS ON COGNITIVE PERFORMANCES AND EMOTIONAL STATES: NEW LESSONS FROM CHILDREN AND ADOLESCENTS"

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Introduction

- It is our **aim** to present and discuss an ongoing research project focused on the interaction effects of morningness-eveningness x time of day on cognitive and emotional variables.
- Literature search shows that a rising number of studies have tested the “synchrony effect” that refers to better performances when people are tested at their peak times of the day (e.g., early hours for morning-types vs. afternoon for the evening-types) and hindered performances at off-peak times (e.g., reading comprehension - Natale & Lorenzetti, 1997 | “Complex” syllogistic, spatial, and arithmetic reasoning - Natale et al., 2003 | memory - Hidalgo et al., 2004 | Intelligence scores - Goldstein et al., 2007 | executive control - Bennet et al., 2008; Hahn et al., 2012; Lara et al., 2014 | attention - Clarisse et al., 2010; Matchock & Mordkoff, 2009).
- Surprisingly, a reverse counterpart, or asynchrony effect, has also been documented (Delpoivre et al., 2014: implicit learning task; May et al., 2005; Rothen & Meier, 2016; Song & Stough, 2000: spatial intelligence tests; Wieth & Zacks, 2011: problem solving/creativity)
- Díaz-Morales & Scribano (2014) remarked that the effects of time-of-day need to be further investigated as they may not follow a pattern merely based on “synchrony and better performance”
- The explanation for conflicting findings seems to reside in the **type of cognitive resources** recruited by different tasks. For instance:
 - Sync effects seem to be present in tasks involving verbal fluency, which require explicit memory and controlled processes.
 - On the contrary, tasks mainly based on implicit processing and automatic processes, which benefit from an attenuation of the inhibition processes, may result in better performances in non-optimal hours.

However, this hypothesis remains to be duly operationalized and tested. Moreover, the topic is virtually unexplored in children.

⇒ Hence, it seems appropriate to fill this gap and consider three different age-groups for a fine probing of the controlled/automatic processes dichotomy, as executive control is known to develop across childhood (Davison, 2006), and schooling induces changes in the level of automatization of tasks recruiting scholastic skills.

⇒ We also aim to explore whether (a)synchrony effects are extendable to emotional states which may interact with cognitive processes.

Methods

General research design

Randomized and blind design, to test diurnal types in different times of the day, inspired in the chronotype-based paradigm (cf. Schmidt et al., 2007, p. 761) and chronopsychology research in general.

2x2 (IV 1 = chronotype: morning- vs evening-type; IV 2 = time of assessment: morning vs afternoon), between subjects, experimental design, with random distribution of morning- and evening-type participants to morning versus afternoon time-of-day assessment

Participants

Participants will be students in three distinct educational grades, corresponding to different chronological ages and developmental phases from childhood to adolescence:

- kindergarten/preschool children (entering age: 5 years-old) -- Note: in Portugal, reading/learning does not take place at this level of education
- primary school children, 3rd grade (entering age: 8 years-old)
- junior high school adolescents, 8th grade (entering age: 13 years-old).

In each sample, from an initial pool of collected questionnaires measuring diurnal type, we will randomly recruit a minimum of 40 participants classified as morning types and 40 classified as evening-types.

Instruments (to be continued)

We propose to systematically probe the relation between core cognitive processes and time-of-day x diurnal type crossings, by using a comprehensive set of neurocognitive tests and emotional states measures.

Instruments

- Children Chronotype Questionnaire [CCTQ]** (Werner et al., 2009, Portuguese version: Couto et al., 2014): to assess morningness-eveningness in 4-11 years old children. It is a 27-item, mixed format, parental report questionnaire, providing three chronotype measures: mid-sleep phase; a sum score in a multi-item morningness/eveningness scales (M/E), and a five-point single chronotype item. The M/E score will be used to determine diurnal type.
- Composite Morningness Scale [CMS]** (Smith et al., 1989; Portuguese version: Silva et al., 1995): to assess chronotypes in adolescents. This is one of the most widely used self-report diurnal type tool. It comprises the best 13 items selected on the basis of psychometric analyses from three well-known measures, retaining items from Horne & Ostberg (1973), Torsvall & Akerstedt (1980). The Portuguese version has been validated by members of our team in adolescents from 12 years-old to 19 and in young adults (cf. Costa et al., 2013; Gomes et al., 2008; 2016).
- EAP-Portuguese version** (adapted by our team, cf. Crisóstomo, 2013) of the **Self-rating Scale for Pubertal Development [SSPD]** (Carskadon & Acebo, 1993): to estimate in a minimally invasive way the stage of pubertal development exclusively in the adolescent participants. This is a 5 item self-report scale adapted by Carskadon and Acebo to be used in studies focusing on adolescent sleep/circadian rhythms. The scores equate to a given pubertal stage corresponding to the Tanner classification.
- Coimbra Neuropsychological Assessment Battery [BANC]** (Simões et al., 2016): to assess cognitive processes in all samples. This is a comprehensive battery validated and normed in a national sample covering the 5-15 age range. It comprises well-known tests designed to assess different cognitive functions: *Memory* (Rey Complex Figure Test, Corsi block task, Face Recognition, Word Learning List, Story Memory), *Language* (Phonological Awareness, Rapid Naming, Token test / instruction comprehension), *Attention/Executive functions* (Zazzo / Toulouse-Piéron cancellation tests; adapt. Trail Making Test A and B; Tower; Semantic and Phonemic Verbal Fluency), *Orientation* (questionnaire), *Motricity* (adapt. Purdue Pegboard Test) and *Laterality* (questionnaire and observation grid).
- Animal Stroop** task for children, and **Stroop Neuropsychological Screening Test (SNST)** (Portuguese versions of Costa & Castro, 2010; Castro et al., 2003): to assess inhibitory processing in children and adolescents, respectively.

To explore each diurnal type time of day oscillations of emotional states, we will use the following tools:

- EAPNC (Escala de Afeto Positivo e Negativo em Crianças, Ameixa, 2013, based on Giacomin & Huttl, 2006)**: this scale is similar to PANAS-C and comprises 30 items organized in two scales: Negative Affect Scale and Positive Affect Scale. The European Portuguese scale has been validated for students ranging from 8 to 14 years of age, and Cronbach alphas >.80. Participant will be asked to indicate for each item how he/ she feels "at this moment".
- STAI anxiety state form**: developed by the Spielberger team for children and adolescents, Portuguese versions: this inventory will be used to assess **anxiety states** at different times of day with participants in the 3rd and 8th grades (no comparable measure is available for pre-school children).

- Faces Scale** adapt. from Andrews & Withey (1976): single item with 7 drawings of a face, distributed horizontally, showing different mouth shapes, from very downturned to very upturned. It has been considered a simple tool to measure momentary happiness or mood during the day, in children (e.g., Holder, 2012) and adolescents (e.g., Díaz-Morales et al., 2015), by asking how the participant feels “in this right moment”. It is also suitable for pre-schoolers (e.g., Veenhoven, 2014).

Permissions and ethical procedures

Permissions requested to the General Direction of Education (Direção Geral de Inovação, Monitorização de Inquéritos em Meio Escolar [DGE-MIME]), which is the Portuguese Ministerial entity that regulates the administration of surveys in schools. Ethical approval requested to the Ethics Committee of the Faculty. We will follow, among others, ethical recommendations for human chronobiological research (Portalupi et al., 2010). After authorization acceptance, permissions will then be requested to schools Directors, and informed consent sent to parents/guardians. We will adopt procedures similar to the ones that prove to be successful in several other earlier projects in children and adolescents conducted by the PI and other team members (e.g., Cruz et al., 2016).

Expected outputs

- Development of a psychoeducational handout** about chronotype inter-individual differences, their specific sleep needs, optimal/non-optimal hours, and strategies to obtain a better adjustment to school schedules
- Educational sessions in schools**: The PR and other project researchers will accept invitations from schools, and will actively promote/organize actions to give talks or psychoeducational sessions for parents, teachers, schools directors, students, etc, about chronotype and its implications on daytime performance and emotional well-being.
- Closing Project Conference**: Also, at the end of the project, the project team will promote a conference at the University to disseminate the results of the project to our students, research peers, professionals in the areas of psychology, education and/or health, etc.

Potencial Implications

The knowledge of how performance and emotional states oscillate for different tasks depending on the time of day and diurnal type have multiple implications in several domains, such as clinical /health, organizational, educational -- e.g., for planning and interpreting cognitive assessments, learning, school starting time decisions, subject-matters distribution across the school day, and examinations' scheduling, among others.

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