

Media multitasking impact in homework, executive function and academic performance in Spanish adolescents

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Abstract

Background: The emergence of multi-function devices has created a perceived need to always be connected to multiple media devices, which is called media multitasking. This phenomenon is linked to deficits in cognitive control affecting executive function and learning and academic achievement in adolescents. The present study aimed to explore the relationship of MM, executive functions and academic performance. **Method:** The sample comprised 977 students aged between 11 and 18 from 6 schools. Media multitasking while doing homework was assessed by the media multitasking index (MMI); executive function was assessed using the DEX-SP and three WISC-IV Subscales; participants' current school marks for mathematics and Spanish language were used to assess academic performance. **Results:** Media multitasking in adolescents is negatively related to executive function and academic achievement. Adolescents who media multitask more while doing homework report more dysexecutive problems. The results of a subsample (n=114) show worse cognitive functioning of the components related to working memory and process speed and lower academic achievement in language and mathematics. **Conclusions:** In the current environment of technology overload, where MM is increasingly frequent, it is necessary to develop adaptive strategies that allow adolescents to focus their attention on tasks and avoid distractions.

Keywords: Media multitasking, homework, executive function, academic performance, adolescents.

Resumen

Impacto del Media multitasking en las tareas escolares, funciones ejecutivas y rendimiento académico en adolescentes españoles. **Antecedentes:** la aparición de dispositivos multifunción ha creado la necesidad de estar constantemente conectados a múltiples dispositivos multimedia simultáneamente, dando lugar al media multitasking. Este fenómeno se relaciona con déficits de control cognitivo que pueden afectar a la función ejecutiva y el aprendizaje. El objetivo principal es explorar la relación entre media multitasking, funciones ejecutivas y rendimiento académico. **Método:** la muestra es de 977 estudiantes de 11-18 años de 6 centros educativos. Se calculó el Índice de media multitasking mientras realizaban tareas escolares; se evaluaron las funciones ejecutivas utilizando el DEX-SP y tres subescalas del WISC-IV; y se tuvieron en cuenta las notas de matemáticas y lengua. **Resultados:** el media multitasking está negativamente relacionado con la función ejecutiva y el rendimiento académico. Los adolescentes que realizaban más media multitasking mientras hacían los deberes informaron de más problemas disejecutivos. Los resultados obtenidos en una sub-muestra (n=114) indicaron un peor funcionamiento cognitivo en tareas que implicaban memoria de trabajo y velocidad de procesamiento e informaron de menor rendimiento académico en lengua y matemáticas. **Conclusiones:** para reducir un impacto negativo del media multitasking es necesario promover el desarrollo de estrategias que permitan a los adolescentes centrar su atención en las tareas evitando distracciones.

Palabras clave: media multitasking, tareas escolares, funciones ejecutivas, rendimiento académico, adolescentes.

Technological progress and the emergence of multi-function devices such as smartphones have created a perceived need for users to always be connected to multiple media devices (Courage, Bakhtiar, Fitzpatrick, Kenny, & Brandeau, 2015). Information and Communications Technology (ICT) accessibility has led to a rise in media multitasking (MM) (Carrier, Cheever, Rosen, Benitez, & Chang, 2009; Rideout, Foehr, & Roberts, 2010).

According to van der Schuur, Baumgartner, Sumter, and

Valkenburg (2015), we can differentiate between two kinds of MM: "using multiple media simultaneously" and "using media while engaging in a non-media activity" (p. 205).

The simultaneous use of different types of media has become a trend and has generated a large and diverse literature regarding its costs and benefits (Courage et al., 2015). MM is a common form of media use (Baumgartner, van der Schuur, Lemmens, & te Poel, 2017), and it is more prominent among adolescents (Rideout et al., 2010; Voorveld & van der Goot, 2013).

Although there is no consensus, several authors concluded that MM is detrimental to speed and accuracy in the performance of a wide range of tasks. Previous research focused on how MM affects attention capacity, mainly addressing whether media multitaskers may lose their ability to fully pay attention to one single task when dispersing their attention to multiple ongoing tasks (Wallis, 2010)

or are able to develop strategies to pay continuous partial attention (Rosen, 2008) to a variety of information sources without fully focusing on any of them.

Recent research has focused on cognitive control abilities, academic performance and socioemotional functioning (Cain, Leonard, Gabrieli, & Finn, 2016; Courage et al., 2015; Murphy, McLauchlan, & Lee, 2017; van der Schuur et al., 2015). These studies related adolescents' MM to their ability to sustain attention, academic achievement and emotional regulation.

Latest investigations showed that a great number of students were unable to study without using a technological device and stated they were not able to go more than 10 minutes without checking their laptops or smartphones (Kessler, 2011). According to Rosen, Carrier, and Chever (2013), is the existence of an emotional need to check their devices, which interrupts the execution of tasks; the anxiety generated by not checking their media devices.

Lezak (1982) was the first to use the term executive functions, defining them as: "The capacities for formulating goals, planning, and carrying out plans effectively, essential for independent, creative, and socially constructive behaviour" (p. 281). Executive functions include cognitive and emotional abilities that allow the planning, executing and supervising of human behaviour. According to Murphy et al. (2017), we can distinguish between three core executive functions: working memory, cognitive flexibility and inhibitory control. Some researchers assume that media multitasking results in deficits in the cognitive control processes (Ophir, Nass, & Wagner, 2009; van der Schuur et al., 2015), interfering cognitive control abilities (Miller & Cohen, 2001) and affecting the three domains of executive function. Accepting these costs of media multitasking implies accepting the *scattered attention hypothesis*. On the other hand, some researchers (Alzahabi & Becker, 2013; Ophir et al., 2009) believe that MM may have a positive effect on cognitive control, supporting the *trained attention hypothesis*, which assumes that "constantly alternating between multiple media may contribute training and improving control processes" (van der Schuur et al., 2015, p. 206).

Early adolescents whose executive functions and self-regulatory process are still developing are more likely to engage in MM. According with Baumgartner et al. (2017) they have fewer abilities to regulate impulses to multitask.

Findings by Baumgartner, Weeda, Heijden, and Huizinga (2014) show how adolescents who engage more frequently in MM report worse executive functions than their peers, having more problems in the three central components of executive function: working memory, "a process which involves the temporary storage and manipulation of information that is necessary for a wide range of complex cognitive activities" (Badeley, 2003, p. 189); inhibition, which involves the ability to filter out irrelevant information and is related to resistance to interference and sustained attention; and cognitive flexibility, also known as shifting, which is the ability to adapt cognitive strategies and adjust to new demands and sudden situations (Diamond, 2013).

Executive functions are often assessed using both rating scales and performance-based tasks. According to Toplak, West, and Stanovich (2013), performance-based tasks involve quite high structure and direction from the researcher, and ratings scales involve very little direction from the researcher. Latest cognitive science investigations suggest that each type of measure taps a different cognitive level of the executive functions and both assess the unique characteristics of these. Specifically, performance-

based measures provide an indication of processing efficiency (the algorithmic mind) and rating measures provide an indication of individual goal pursuit (the reflective mind).

A large number of investigations show that not always the results of these measures should be strongly correlated. In order to fully evaluate adolescents' executive function, this study has used both measures. With the purpose of selecting both rating scales and performance-based tasks we used a review from Toplak et al. (2013) in which the association between these two types of measures was investigated. In this review, authors found that the most common rating scales to assess executive function are BRIEF and DEX; and a great number of performance based tasks were used to assess different aspects of executive function, such as: Digit Span and N-back (both indicators of working memory).

Recent studies have examined whether MM may affect working memory capacity. According to Goleman (2012), working memory is the most important executive function in cerebral activity and makes any other intellectual activity possible. This function is considered essential for cognitive processes such as reasoning and is related to learning and academic performance (Corral, Arribas, Santamaría, Sueiro, & Pereña, 2005) and attention capabilities (Gioia, Isquith, Kenworthy, & Barton, 2002). Sanbonmatsu, Strayer, Medeiros-Ward, and Watson (2013) used a performance-based task to assess working memory and MMI (Ophir et al., 2009); their results showed that higher scores in MM were linked to worse performance in working memory skills.

With regard to cognitive flexibility, Minear, Brasher, McCurdy, Lewis, and Younggren (2013) made a replication of Ophir et al. (2009) study. They used both self-reports and performance-based tasks to measure the ability to inhibit distracting information and no longer relevant information in working memory. Their results did not reveal any differences between heavy multitaskers and light multitaskers. In contrast, Ophir et al. (2009) in the original study reported that heavy media multitaskers have worse task-switching skills than light media multitaskers.

Several investigations have explored the relationship between MM and inhibition (Murphy et al., 2017). Whereas Ophir et al. (2009) concluded that there was no difference in this ability between light and heavy media multitaskers, findings by Baumgartner et al. (2017) and Magen (2017), both using MMI (Ophir et al., 2009) and performance based tasks, have linked greater MM with poorer inhibitory response control.

Research show that MM during learning (in class or at home) can negatively affect academic achievement (Law & Stock, 2017). According with Levine, Waite, and Bowman (2007) instant messaging was significantly associated with higher levels of self-reported distractibility for academic tasks. A recent study with students who participated in the 2012 Programme for International Student Assessment (PISA) showed that ICT usage at home for schoolwork and ICT usage at school for mathematics were negatively related to mathematics achievement (Bulut & Cutumisu, 2017). They conclude that students do not effectively self-regulate MM and are poor at recognizing and regulating inhibitors of performance. They emphasized that self-regulation of multitasking habits is a necessary skillset for the students. Cain et al. (2016), found that adolescents who had higher reports of media multitasking in daily life had poorer performance on state-wide standardized achievement tests of math and English and showed a poorer performance on behavioural measures of executive function (working memory capacity) in a performance based task.

Van der Schuur et al. (2015) summarized the findings of a large number of researchers and concluded that there were two explanations for the hypothesis that engaging in MM during academic tasks can affect academic performance among adolescents: 1) time spent using media during academic activities may displace the time spent on academic activities (Fox, Rosen, & Crawford, 2009) and 2) using multiple streams of information decreases information processing as a result of limited cognitive capacity (Salvucci & Taatgen, 2010).

Ophir et al. (2009) explained the link between the *scattered attention hypothesis* and MM and poorer academic performance, sustaining that MM can result in deficits in cognitive control. Following the link between attention problems and academic performance, Baumgartner et al. (2017) explored 3 possible relationships between MM and adolescents' attention problems: 1) engaging in MM leads to attention problems because adolescents have to constantly switch their attention from one media content to another task and the information processing capacities are limited; 2) attention problems lead to more MM, being the inability to filter out irrelevant information and the media guides their attention; and 3) MM and attention problems can be reciprocally related.

The present study aimed to determine the prevalence of multitasking among the adolescent population studied, exploring the relationship of MM, executive functions and academic performance. We have compared the academic performance and executive functions of students who have reported high levels of MM while doing homework, according MMI (Baumgartner et al., 2014), and all others.

Method

Participants

The sample comprised 977 students (51.9% girls; 48.1: boys) aged between 11 and 18 (mean age: 14.37; SD: 1.78). The pupils were randomly selected using the cluster random sampling technique, with the classroom as the cluster and stratified by school type (public and private-part subsidized) and school year. Participants are from 6 educational centres of the Alt Empordà region (Girona, Spain), most of which are state-run (84.8%).

Instruments

Self-attributed scale of ICTs' use (Casas et al., 2007). A single-item scale which asks adolescents what kind of ICT consumer they consider themselves according to the following categories: 1: *I never or nearly never use it*; 2: *I'm a low consumer*; 3: *I'm a medium consumer*; 4: *I'm quite a high consumer*; 5: *I'm a very high consumer*. This scale was used to obtain a self-reported measure of adolescents' level of ICTs consumption. Reliability cannot be evaluated because it is a single item scale and therefore Cronbach's alpha cannot be obtained. Casas et al., 2007 to validate this single item scale made a correlation between the number of hours of the ICTs use and the self-categorization. In their study found a good congruence of answers ($r=457, p < 0.001$).

The Media and Technology Attitudes Scale (Rosen, Whaling, Carrier, Cheever, & Rökkum, 2013). We use the three attitudinal items of the Anxiety/dependence subscale to explore the tendency of the adolescents to show attitudes of concern, nervous, and dependence on media and Technology. (e.g. "I get anxious when I

don't have my cell phone."). Adolescents were asked to what extent they agreed (from 1 to 5) with each item. Internal consistency was good ($\alpha = .83$).

Media multitasking index. Was assessed by means of an adapted version of the measure proposed by Ophir et al. (2009) and similarly used by Baumgartner et al. (2014). We assess the same nine media activities: watching TV, reading, listening to music, talking on the phone, sending messages, talking on the phone, social networking, online videos, other computer activities, and video games. By contrast with the study by Baumgartner et al. (2014), where participants were asked how often they engage in each media activity simultaneously with each of the other eight media activities, in our study they were asked to indicate how often they engage in these 9 different MM activities while doing homework. The scale is rated on a Likert scale of 1-4 points from 1 (never) to 4 (very often) ($\alpha = .84$). We summed the scores for each activity obtaining the average with which the nine media activities are carried out while doing homework. We calculate the index of MMHW dividing the average of each activity by the total number of activities (9).

Spanish version of the Dysexecutive Questionnaire (DEX-SP) (Wilson, Alderman, Burgess, Emslie, & Evans, 1996). Self-reported questionnaire consisting of 20 items, rated on a 5-point Likert scale (1: "hardly ever" – 5 "often"), measuring dysexecutive syndrome in adolescents. We used the 5 factors (planning, inhibition, impulsivity-perseverance, persistence and response inhibition-hyperkinesia) detected by means of factorial analysis in the Spanish version (Pedrero et al., 2009) ($\alpha = .95$).

Spanish version of the Wechsler Intelligence Scale for Children Fourth edition (WISC-IV) (Corral et al., 2005). We used the following three subscales: *Digit Span*. Used to measure working memory capacity and also related to cognitive flexibility, attention, learning abilities and academic achievement. *Symbol Search* and *Coding*: used to evaluate processing speed and also related to cognitive flexibility, attention and learning abilities.

Current school marks. Students were asked for their last marks of Catalan and Math Marks. Adolescents indicated this on these categories: fail (less than 5), pass (5-6), good (7-8) and excellent (9-10).

Procedure

After requesting the corresponding permission from the Government of Catalonia's Department of Education, we contacted the educational centres. The head teacher of each school was informed of the characteristics and aims of the research. We followed the ethical guidelines of the Helsinki Declaration, with written informed consent obtained by the participants' parents. Schools and participants were guaranteed data confidentiality and anonymity.

First, we proceeded with the administration of self-reports to the total sample ($n=977$). Participants received specific, homogenous instructions regarding how the questionnaire should be answered. They were accompanied by instructors who had received prior training in the research to give any help or clarification. Based on participants' responses to the MM during homework items, we created two groups: Heavy Media Multitasking during Homework group (HMMHW), adolescents who have obtained a score in the MMHW index equal or higher than the mean score plus the standard deviation ($n=269$); Normative group: adolescents

who don't who have obtained a score lower than the mean score plus the standard deviation (n=708).

Following that, we administered three WISC-IV subscales to a sub-sample of both groups (n=114): 55 adolescents of the HMMHW group and 59 adolescents of the normative group randomly selected and controlled by gender and age variables.

Data analysis

Data were analysed according to gender and school year using the Student's t-test to compare means, and through the Chi-square test to compare proportions. Considering the possible impact of the adolescents' age on the dysexecutive function a two-way ANOVA has been carried out.

We used statistical package SPSS, version 23.0 for all of the data analysis. The minimum level of statistical significance required in all tests was $p < .05$.

Due to the small number of students aged 11 and 18, and in order to adjust the data to make more homogeneous age groups, 11 and 12 year-olds were grouped together, as were 17 and 18 year-olds.

Results

Table 1 shows the means and standard deviations for the multitasking media activities while doing homework. "Listening to music" and "Sending messages by mobile" were the activities that obtained the highest means.

27.5% (n=269) of participants from the total sample were included in HMMHW group. There were differences by age but not by gender (see Table 2).

Participants classified in HMMHW group show significantly higher scores than the normative group concerning the self-attributed scale of ICTs use by groups.

In the HMMHW group, 84.9% (n = 219) categorized themselves as "fairly high consumer" or "very high consumer", $\chi^2(4, N = 955) = 32.747, p < .001$.

The results of the attitudes scale of the HMMHW group show higher scores ($M = 3.05, Sd = 1.13$) in Anxiety-Dependence dimension than normative group ($M = 2.58, Sd = 1.08$), these differences are statistically significant ($t(975) = -6.058, p < .001$).

MMHW and executive function

In two-way ANOVA (Age and MMHW group) analysis it hasn't been found any effect between age and DEX-sp dimensions and with the overall score. Taking into account the aggrupation of MMHW, it can be observed the effect between MMHW and all dimensions of the DEX-Sp: planification ($F(1,976) = 23.218, p < .001, \eta^2 = .023$), inhibition ($F(1,976) = 42.902, p < .001, \eta^2 = .043$), impulsivity - perseverance ($F(1,976) = 10.813, p = .001, \eta^2 = .011$), persistence ($F(1,976) = 26.484, p < .001, \eta^2 = .027$), response inhibition -hyperkinesia ($F(1,976) = 18.145, p < .001, \eta^2 = .022$) and with the overall score ($F(1,976) = 42.308, p < .001, \eta^2 = .042$). It has been found and interaction effect in the dimensions of planification ($F(5,976) = 2.923, p = .013, \eta^2 = .015$), inhibition ($F(5,976) = 2.396, p = .036, \eta^2 = .012$), persistence ($F(5,976) = 22.422, p = .019, \eta^2 = .014$) and with the overall score of the DEX-sp ($F(5,976) = 3.469, p = .004, \eta^2 = .018$) between the MMHW and the age.

Specifically, in the 12 years-old adolescents the impact of MMHW has a higher impact than 16 years-old adolescents. So, the results show how at more age the impact of MMHW decreases.

HMMHW sub-sample group performed worse in all three subscales of the WISC-IV. If we compare the mean scale

| While doing homework, how often do you do these activities at the same time? | Mean | SD |
|--|------|------|
| TV | 2.20 | 1.16 |
| Music | 3.11 | 1.10 |
| Reading | 2.11 | 1.13 |
| Phoning | 2.15 | 1.14 |
| Sending messages (with mobile phone) | 3.08 | 1.08 |
| Social Networking Sites | 2.53 | 1.24 |
| Online videos | 2.07 | 1.23 |
| Other computer activities | 2.61 | 1.16 |
| Video gaming | 1.79 | 1.14 |

Note: The media multitasking scores have values ranging from 1 (never) to 4 (very often)

| | HMMHW group | | | | Total | % | χ^2 | p | ϕ |
|------------|-------------|-------|------------|-------|-------|-------|----------|------|--------|
| | Yes (n=269) | | No (n=708) | | | | | | |
| | n | %(*) | n | % | | | | | |
| Sex | | | | | | | | | |
| Boys | 139 | 51.7% | 331 | 46.8% | 470 | 48.1% | 1.89 | n.s. | -.04 |
| Girls | 130 | 48.3% | 377 | 53.2% | 507 | 51.9% | | | |
| Age | | | | | | | 12.46 | .029 | V |
| 11-12 | 41 | 15.2% | 127 | 17.9% | 168 | 17.2% | | | |
| 13 | 73 | 27.2% | 129 | 18.2% | 202 | 20.7% | | | |
| 14 | 46 | 17.1% | 103 | 14.5% | 149 | 15.3% | | | |
| 15 | 38 | 14.1% | 117 | 16.5% | 155 | 15.9% | | | |
| 16 | 39 | 14.5% | 131 | 18.5% | 170 | 17% | | | |
| 17-18 | 32 | 11.9% | 101 | 14.3% | 133 | 13.6% | | | .04 |

scores, they are always higher in the normative group. However, statistically significant differences are only observed in the Digit Span and Symbol Search (see Table 3).

MMHW and academic achievement

If we compare these self-reports of academic achievements, MMHW group reported worse academic achievement in Math and Catalan. The percentages of fails in these two subjects were more frequent in the HMMHW group. In contrast, the normative group obtained a good or excellent mark more frequently than the HMMHW group (see Table 4).

Discussion

The present study was focused on exploring the relationship between MM while doing homework, executive function and academic achievement in a sample of Spanish adolescents.

The prevalence of MM while doing homework was high according with other studies (Carrier et al., 2009; Rideout et al., 2010), with 27.5% of adolescents being included in the HMMHW group.

The high scores of ICTs anxiety/dependence of HMMHW group show an emotional need arises as a result of these anxious and dependent feelings, which leads to adolescents interrupting tasks to check their devices (Rosen et al., 2013).

Contrary with studies that found that girls are somewhat more likely to engage in MM (Baumgartner et al., 2014), in this study no differences were found by gender. The 11-13 year-olds represented 42.4% of HMMHW group; thus confirming high prevalence of MM among early adolescents found in prior investigations (Baumgartner et al., 2017) which can be explained with the lower self-regulatory skills to control impulses to multitask of younger adolescents.

According to DEX-SP finding, the HMMHW group reported more dysexecutive symptoms in their daily lives, obtaining significantly higher scores in all dimensions and in overall

score. Adolescents of this group reported having more frequent problems in planning and decision-making skills, a lack of skills related to response inhibition, a tendency to be restless and a lack of involvement with regard to social rules than the normative group. These findings coincide with the results of the self-reported questionnaire (BRIEF) used by Baumgartner et al. (2014) in which adolescents who multitask more frequently reported more problems staying focused, inhibiting inappropriate behaviour, and switching effectively between tasks. Although the age has not associated to executive dysfunction, the interaction found between the adolescents' age and MMHW suggests that the effect of MMHW on executive dysfunction is more prominent in early adolescents. It seems that MMHW has a greater effect on adolescents of 12 years-old. This fact can be related with the higher executive dysfunction on early adolescents than older adolescents.

In all WISC-IV tasks, the HMMHW group also obtained scores that indicate a lower performance of the executive function. In subscales related to processing speed (Coding and Symbol Search) and working memory (Digit Span), this group obtained lower scores than the other. These results coincide with the findings of Cain et al. (2016), which also found a negative relationship between working memory and MM.

The three WISC-IV subscales are related to the assessment of attentional skills. Given the relationship between working memory and the skills of focusing and controlling attention (Gioia et al., 2002), the adolescents of HMMHW group could have attention deficits related to their recurrent use of multiple communication media simultaneously.

Although previous research found discrepancy between the findings for the self-reported and performance-based instruments of executive functions (Baumgartner et al., 2014; Toplack et al., 2013), our results of both types of measures could show similar findings showing more executive function problems in the HMMHW group. However it is important to highlight the small size of the sub sample to which the WISC-IV tasks were administered. So this is a limitation of this research that should be taken into account when comparing self-report results with WISC-IV tasks.

Regarding the relationship between MM during homework and academic performance, HMMHW group reported worse marks for language and math. These differences are evident in the extreme percentages obtained. These results correspond with the findings of Junco and Cotten (2011) and van der Schuur et al. (2015), who stated that high levels of MM can lead to problems at school. According to Fox et al. (2009), MM can generate distractions when carrying out school tasks or, in other words, lead to attention deficit.

Overall these findings suggest that MM in adolescents is negatively related to executive function and academic achievement.

Table 3
WISC-IV sub-scales mean scores

| WISC-IV Sub scales | HMMHW | | Control group | | $t_{(90)}$ | p | d |
|--------------------|-------|-------|---------------|-------|------------------------|------|-----|
| | n | Mean | n | Mean | | | |
| Coding | 55 | 10.76 | 60 | 11.50 | 1.268 ₍₁₁₃₎ | n.s. | .24 |
| Digit Span | 55 | 8.80 | 60 | 10.37 | 3.095 ₍₁₁₃₎ | .002 | .58 |
| Symbol Search | 55 | 8.87 | 60 | 10.35 | 2.361 ₍₁₁₃₎ | .020 | .44 |

Note: The scores for each sub scale were standardized as scalar punctuations of the WISC-IV.

Table 4
Catalan and Math marks

| | HMMHW (%) | | | | Normative group (%) | | | | χ^2 | p | V |
|---------|-----------|------------|---------|------------------|---------------------|------------|---------|------------------|----------|-------|-----|
| | Fail (-5) | Pass (5-6) | B (7-8) | Excellent (9-10) | Fail (-5) | Pass (5-6) | B (7-8) | Excellent (9-10) | | | |
| Catalan | 27.5 | 43.9 | 24.9 | 3.7 | 20.8 | 38.1 | 31.2 | 9.9 | 17.227 | .001 | .11 |
| Math | 30.5 | 40.9 | 20.4 | 8.2 | 24.2 | 30.9 | 30.9 | 14 | 21.706 | <.001 | .06 |

Adolescents who more media multitask while doing homework tended to report: more dysexecutive problems in their everyday life, worse cognitive functioning of the components related with working memory and process speed and lower academic achievement in language and math.

These results may be explained via the scattered attention hypothesis (Ophir et al., 2009), concluding that worse results of the HMMHW group can be related with the full attention skill deficits caused by high frequencies of MM.

Following Baumgartner et al., (2017), it would be interesting to propose a future investigation in which the implications of MM in the attention capacity of adolescents will be evaluated. In this sense, a longitudinal study could be proposed which, in addition to evaluating MMI and executive functions, would include a measure of attention problems such as the one proposed by Kessler et al. (2005).

Otherwise, MM could be also explained by a lack of self-control and emotional regulation in adolescents. Responses for the scale of attitudes toward ICTs revealed significant differences between the two groups in the dimension evaluating anxiety-dependency. Adolescents of the HMMHW group agreed more with the items evaluating anxious responses when facing the non-availability of mobiles and the Internet and dependence on technological devices. In the same line as Rosen et al. (2013), our findings show an emotional need among adolescents that leads them to constantly check their technological devices.

In the current environment of technology overload, where MM is increasingly frequent, it is necessary to develop adaptive strategies

that allow adolescents to focus their attention on tasks and avoid distractions. These strategies should focus on the development of emotional intelligence skills such as: controlling impulses, self-awareness, motivation, enthusiasm and perseverance (Goleman, 2012).

The present study has some limitations. Although the sample is representative of the adolescent population studied, it does not allow for the generalization of results to other populations. Because of the cross-sectional design the causality of the relationship between MM, executive function and academic achievement cannot be established. Given the scarcity of longitudinal studies on the relationship between MM and executive function (Baumgartner et al., 2017), a possible fruitful future line would be to conduct a longitudinal study which allow us to show conclusions about cause-effect relationship of executive function and academic performance evaluating the development of these from the early adolescence. Another aspect to consider is the limitation of identifying adolescents who made more media multitasking based on self-reports. In general terms, teens are good informants although in the collective context it is likely to be bias. Therefore, self-reports should be supplemented with objective measures such as observation or performance based tasks (Beard, 2005). Finally, the reduced size of the sub-sample to which the WISC-IV scales were administered implies that we cannot firmly affirm the differences found between rating scales and performance based tasks. In future investigations it would be necessary to examine the same number of participants in both types of instruments.

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