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# Effect of augmented reality game Pokémon GO on cognitive performance and emotional intelligence in adolescent young

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A B S T R A C T

The main aim was to analyse the effect of 8 weeks of Pokémon GO on cognitive performance (memory, selective attention, concentration, mathematical calculation and linguistic reasoning) and emotional intelligence (well-being, self-control, emotionality and sociability) in Spanish adolescents between 12 and 15 years. A longitudinal design was used, with a Control Group (n = 103) that did not use Pokémon GO, and Experimental Group (n = 87) that used Pokémon GO during 8 weeks. Age, sex, BMI, maternal educational level, number of computers at home and moderate to vigorous physical activity (MVPA) were used as confounders. Results showed that players walked 54 km and spent 40 min/day playing in this period. Boys played more, won more points and reached a higher level in the game than girls. The players playing Pokémon GO significantly increased their selective attention ($p = 0.003$), concentration levels ($p < 0.001$), and sociability levels ($p = 0.003$) against their peers. It is concluded that Pokémon GO increases, in a playful way, the amount of daily exercise in adolescents, could positively affect their cognitive performance, and improve the social relationships. Further studies are required to perform comparisons between single and collaborative play and to identify the pedagogical benefits through some subjects such as Physical Education.



## 1. Introduction

Cognitive performance (CP) is the mental capacity affected by the inhibitory control and executive functions, which are the factors responsible for the planning, intellectual organization and behaviour control (Diamond, 2013; Ruiz-Ariza, Grao-Cruces, Loureiro, & Martínez-López, 2017). Memory, selective attention, concentration, and numeric-linguistic reasoning abilities appear among the most important variables in CP (Diamond, 2013; Esteban-Cornejo, Tejero-Gonzalez, Sallis, & Veiga, 2015; Ruiz et al., 2010; Ruiz-Ariza et al., 2017). It has been found that young people with high CP have a greater self-esteem and self-concept (Fati-Ashtiani, Ejei, Khodapanahi, & Tarkhorani, 2007) and they show less risk of chronic widespread pain

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(Gale, Deary, Cooper, & Batty, 2012). However, low CP has been associated with anxiety disorder (Martin et al., 2007), psychological distress (Gale, Hatch, Batty, & Deary, 2008), and depression (Jaycox et al., 2009).

When cognition interacts with emotional aspects, behavioural responses and adaptations appear, and they compose Emotional Intelligence [EI] (Salovey & Mayer, 1990). For some authors, EI is a construct composed of well-being, self-control, emotionality and sociability (Petrides, 2009, pp. 85–101; Petrides et al., 2016). A good level of EI is associated with adaptive behaviours and social skills (Frederickson, Petrides, & Simmonds, 2012), with leadership qualities, and with few possibilities for being disruptive, aggressive, and dependent in the school context (Mavroveli, Petrides, Sangareau, & Furnham, 2009). Moreover, EI can inhibit maladaptive actions like bullying, victimization and psychopathology in adolescence (Kokkinos & Kipritsi, 2012; Petrides et al., 2016; Salovey & Mayer, 1990). Both, CP (Esteban-Cornejo et al., 2015; Ruiz-Ariza et al., 2017) and EI (Frederickson et al., 2012; Mavroveli & Sanchez-Ruiz, 2011; Petrides et al., 2016) are highly determinant to get better academic performance at school and greater future job success (Laidra, Pullman, & Allik, 2007; Perera & DiGiacomo, 2013).

CP and EI share the influence of some socio-cultural factors such as family socioeconomic status (Esteban-Cornejo et al., 2015), school environment (Ruiz-Ariza et al., 2017), educational level of family (Ruiz et al., 2010; Petrides, 2009), and the weekly practice of Physical Activity [PA] (Esteban-Cornejo et al., 2015; Hogan, Catalino, Mata, & Fredrickson, 2015; Laborde, Dosseville, & Allen, 2016; Ruiz-Ariza et al., 2017). The last variable is a key element because it improves the memory (Chaddock-Heyman, Hillman, Cohen, & Kramer, 2014), selective attention and concentration (Cadenas-Sanchez et al., 2016; Vanhelst et al., 2016), arithmetic skills (Moore, Drollette, Scudder, Bharij, & Hillman, 2014), linguistic reasoning abilities (Scudder et al., 2014), well-being (Ruiz-Ariza, de la Torre-Cruz, Redecillas-Peiró, & Martínez-López, 2015), self-control (Donnelly & Lambourne, 2011), emotionality (Azevedo, Burges-Watson, Haighton, & Adams, 2014) and sociability (Kato et al., 2016; Tateno, Skokauskas, Kato, Teo, & Guerrero, 2016). In addition, PA practice is easily modifiable in young people because it largely depends on parental (Martínez-López, Lopez-Leiva, Moral-Garcia, & De la Torre-Cruz, 2014) and social support, especially from their peers (Hogan et al., 2015). Despite the above, 81% of adolescents do not reach the minimum recommended daily amount of PA, and demotivation to PA as well as the sedentarism level have increased in the last years (Mielgo-Ayuso et al., 2016; WHO, 2016). The young currently spend around 8.6 h/day in sedentary behaviours, mostly associated with the use of new technologies watching television, smartphones, computers, or playing videogames (Norris, Hamer, & Stamatakis, 2016). The Global Monitoring Framework for Noncommunicable Diseases established a global objective of 10% reduction of sedentarism by 2025 (WHO, 2012). Thus, there is an urgent need to find new strategies aimed at motivating the young to go outside and practise more PA (LeBlanc & Chaput, 2016).

A novel strategy for promoting PA among young people are the Augmented Reality Games (ARG), defined as a kind of exergame active video game that requires participants to be physically active or to do exercise in order to play the game (Anderson, Steele, O'Neill, & Harden, 2016; Clark & Clark, 2016). ARG combine the physical and virtual worlds into one interface, replacing stationary play with active play by requiring users to explore their physical surroundings (Serino, Cordrey, McLaughlin, & Milanaik, 2016). In addition, some recent researches have shown that augmented reality could also increase other educational development characteristics as the quality of writing (Wang, 2017), mathematical abilities (Sommerauer & Müller, 2014) or to learn a foreign Language in young people (Hsu, 2017). Among ARG, Pokémon GO has gained significant fame in a very short time. It is the first mass market app that is fully immersed into actual geographical space and that transcends the virtual, the spatial, the social and the physical (Clark & Clark, 2016; Tateno et al., 2016). It was released on 7 July 2016 in the USA and Oceania, and on 16 July in Spain and other European countries. Within 1 week of its release, the game attracted over 65 million users, most of them teenagers (Nigg, Mateo, & An, 2016; Serino et al., 2016). The aim is to catch and level up Pokémon and your avatar across various tasks and by visiting several physical locations using mobile GPS (Anderson et al., 2016). In this way, Pokémon GO allows young people to keep motivated by playing video games and at the same time to increase daily PA levels (Clark & Clark, 2016; LeBlanc & Chaput, 2016; Serino et al., 2016), decrease sedentary behaviours (Nigg et al., 2016), enhance fitness and overall cardiometabolic health (Krittanawong, Aydar, & Kitai, 2017; Sharma & Vassiliou, 2016), prevent and treat many chronic diseases (Anderson et al., 2016), decrease obesity (Smith, 2016), carry out family activities (De Oliveira-Roque, 2016), or prevent depression and anxiety (McCartney, 2016). According to Serino et al. (2016), other benefits could be increased socialization and group outdoor activity. In this sense, Tateno et al. (2016) and Kato et al. (2016) have currently concluded that Pokémon GO may help youth with severe social withdrawal.

The relationship of PA practice with improvements in CP and EI has been verified by cross-sectional (Cadenas-Sanchez et al., 2016; Laborde et al., 2016; Vanhelst et al., 2016) and longitudinal studies (Laborde et al., 2016; Stephan, Sutin, & Terraccioano, 2014). However, these results need to be treated with caution due to the possible mediation of major confounders like age (Esteban-Cornejo et al., 2015), sex (Ardoy et al., 2014), socioeconomic status (Ruiz-Ariza et al., 2017), maternal education (Cadenas-Sanchez et al., 2016; Vanhelst et al., 2016), body mass index (BMI) (Bezold et al., 2014), or moderate to vigorous physical activity [MVPA] (Ruiz-Ariza et al., 2017). The potential of exergames for the transformation of sedentary time into physically active time has recently been demonstrated in young people (LeBlanc & Chaput, 2016; Nigg et al., 2016), but knowing if the combination of PA with search objectives, by using Pokémon GO, improves CP and EI has not yet been studied enough. This research aims to focus on adolescence because it is a key stage to consolidate healthy lifestyles and increase the PA level. In addition, during this period there is a high degree of plasticity in the brains of young people, which is decisive in enhancing CP and EI, improving academic performance, securing appropriate behaviours, and fostering future social success (Esteban-Cornejo et al., 2015; Petrides et al., 2016; Ruiz-Ariza et al., 2017).

From the preceding reasoning, we hypothesize that young people who have played Pokémon GO could show higher levels of CP and EI than their peers. The main aim was to analyse the effect of 8 weeks of Pokémon GO on CP and EI in Spanish adolescents between 12 and 15 years, independently of age, sex, socioeconomic status, maternal education, BMI and MVPA. Additionally, it was also intended to describe the sociodemographic characteristics associated with Pokémon GO players and their degree of satisfaction with the game.

## 2. Methods

### 2.1. Design

Quantitative randomized and longitudinal study with Control Group (CG) [n = 103] that did not use Pokémon GO, and Experimental Group (EG) [n = 87] that used Pokémon GO during 8 weeks.

### 2.2. Participants

Table 1 shows the anthropometric and sociodemographic characteristics, as well as CP and EI values of participants. 190 adolescents from two summer schools from Andalusia (Spain) took part in this study. Adolescents were aged 13.32 ± 1.07 years (range = 12–15 years), had a BMI of 20.19 ± 3.11 kg/m$^2$ (range = 13.19–33.00 kg), and a mean of computers at home of 2.51 ± 1.43 (range = 1–7). Participants carried out a mean of 3.58 ± 1.57 days/week of MVPA (range = 0–7), and studied 110 ± 46.95 min/day (range = 21.71–214.29). 45.8% of participants often played Pokémon GO. These young people also had a higher number of computers at home than non-players (2.77 ± 1.53 vs. 2.29 ± 1.31, respectively, $p = 0.023$). Adolescent girls played daily less than boys (26.4 vs. 73.6%, respectively, $p < 0.001$). No initial differences were found between the CG and EG in other socioanthropometric measures nor in CP-EI measures (all $p > 0.05$). The structure used for group formation and intervention characteristics is shown in Fig. 1.

### 2.3. Measures

#### 2.3.1. Cognitive performance

To assess memory, an *ad hoc* test of 1 min was used, from the original ideas of Wechsler (1945) and Tombaugh (1996), and from the memory test included in the Spanish adaptation of the RIAS test (Santamaría-Fernández & Fernández-Pinto, 2013). A poster of 15 Spanish playing cards, randomly selected, was projected for 20 s on a 3 × 2 m screen. Immediately afterwards, the participants had 40 s to record on a standardized sheet the largest number of remembered cards. The total number of correct answers (range 0–15) was counted. Before the test, it was verified that all the participants knew the structure and content of the 40 cards of the Spanish deck. The reliability test-retest (48 h, $n = 21$) was 0.919.

**Table 1**
Antropometric, sociometric, cognitive, and emotional charasteristics, of participants. Values are presented as mean and standard deviation, or percentage.

| | | All (*n = 190*) | GC (*n = 103*) | GE (*n = 87*) | *p* - Value |
|---|---|---|---|---|---|
| Age | | 13.32 ± 1.07 | 13.21 ± 1.00 | 13.48 ± 1.09 | 0.072 |
| Sex (%) | Girl | 94 (49.5) | 71 (68.9) | 23 (26.4) | <0.001 |
| | Boy | 96 (50.5) | 32 (31.1) | 64 (73.6) | |
| Weigh | | 54.97 ± 10.30 | 55.34 ± 8.79 | 54.77 ± 11.94 | 0.711 |
| High | | 1.61 ± 0.08 | 1.60 ± 0.07 | 1.62 ± 0.09 | 0.066 |
| BMI | | 20.19 ± 3.11 | 20.56 ± 2.88 | 19.78 ± 3.37 | 0.103 |
| Computers at home (n) | | 2.5 1 ± 1.43 | 2.29 ± 1.31 | 2.77 ± 1.53 | 0.023 |
| Daily time studying (min/day) | | 110.54 ± 46.95 | 114.32 ± 5.23 | 105.84 ± 43.94 | 0.247 |
| MVPA (days/week) | | 3.53 ± 1.57 | 3.74 ± 1.49 | 3.37 ± 1.65 | 0.116 |
| Internet access (%) | No | 7 (3.8) | 4 (4) | 2 (2.4) | 0.428 |
| | Yes | 179 (96.2) | 95 (96) | 81 (97.6) | |
| Maternal education (%) | No studies | 3 (1.6) | 3 (3) | 0 (0) | 0.067 |
| | Primary School | 14 (7.4) | 4 (4) | 10 (11.5) | |
| | Secondary School | 66 (34.7) | 38 (38.4) | 26 (29.9) | |
| | University studies | 107 (56.3) | 54 (54.5) | 51 (58.6) | |
| Memory | | 5.03 ± 1.80 | 4.94 ± 1.70 | 5.13 ± 1.92 | 0.484 |
| Selective attention | | 164.54 ± 37.731 | 160.73 ± 41.30 | 169.06 ± 32.66 | 0.130 |
| Concentration | | 157.32 ± 50.01 | 151.99 ± 46.97 | 163.62 ± 52.98 | 0.110 |
| Mathematical calculation | | 7.18 ± 3.09 | 6.83 ± 2.94 | 7.60 ± 3.24 | 0.087 |
| Linguistic reasoning | | 21.61 ± 3.58 | 20.81 ± 4.04 | 21.95 ± 3.50 | 0.272 |
| Emotional Intelligence | Well-being | 4.42 ± 0.73 | 4.44 ± 0.75 | 4.40 ± 0.71 | 0.708 |
| | Self-control | 4.14 ± 0.70 | 4.07 ± 0.76 | 4.22 ± 0.62 | 0.154 |
| | Emotionality | 3.93 ± 0.81 | 3.87 ± 0.81 | 3.95 ± 0.71 | 0.496 |
| | Sociability | 4.37 ± 0.72 | 4.32 ± 0.76 | 4.43 ± 0.67 | 0.325 |

CG=Control Group. EG = experimental Group. BMI=Body Mass Index. MVPA = Moderated to Vigorous Physical Activity.

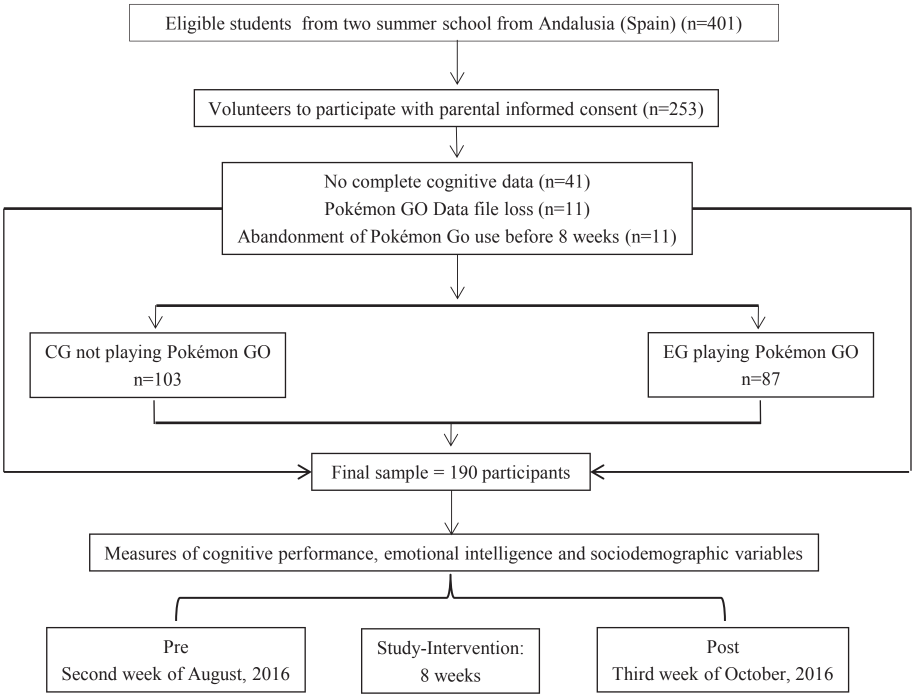


**Fig. 1.** Flow of participants. CG = Control Group. EG = Experimental Group.

Selective attention and concentration capacity were assessed under stress induced by a completion time using the d2 Test of Brickenkamp in the Spanish version (Seisdedos, 2012). The d2 Test assesses performance in terms of visual perceptual speed and concentrative capacities by assessing an individual's ability to selectively, quickly and accurately focus on certain relevant aspects in a task while ignoring other irrelevant aspects. The d2 Test is a paper-and-pencil letter-cancellation test comprising 14 different lines, each containing 47 randomly mixed letters (*p* and *d*), for a total of 658 letters. The letters *p* and *d* appear with 1 or 2 dashes above or below each letter. The test subject has to carefully check whether each letter "d" has 2 dashes either above or below it, at a rate of 20 s per line, always starting from left to right and continuing from top to bottom. The complete duration of the test is 4 min and 40 s. Selective attention capacity was calculated using the following formula: [number of processed elements−(omissions + mistakes)]. In addition, the concentration was calculated with: (Number of hits − number of mistakes). The reliability test-retest (48 h, n = 21) was 0.911.

To analyse mathematical calculation an *ad hoc* test was used. This test was based on the previous studies by Jastak and Wilkinson (1993), and Passolunghi and Siegel (2004), who checked the processing capacity, speed and resolution of mathematical operations. This test included 2 groups of additions and subtractions with 6 digits (i.e. 8−6 + 5 + 8−6 = 9). Participants had 1 min to perform as many operations as possible, and the total number of hits was counted. Test-retest reliability (48 h, $n = 21$) was 0.931.

To evaluate the reading speed and semantic comprehension of participants Linguistic reasoning, an *ad hoc* test was developed based on Lervåg and Aukrust (2010), and the *Neale Analysis of Reading Ability [NARA test]* (https://www.gl-assessment.co.uk/products/neale-analysis-of-reading-ability-nara/). The test showed 30 rows of 4 words each. In each row of words, 3 belonged to the same semantic field while a fourth had no relation to the others (i.e. car, dog, motorbike, lorry). The order of these was randomly established. For a minute, the students had to cross out the largest number of words that had no relation *intruder words*. The total number of correctly crossed out words was counted. The reliability test-retest (48 h, $n = 21$) was 0.841.

### 2.3.2. Emotional intelligence

To assess the EI, the *Trait and Emotional Intelligence Questionnaire Short Form* (TEIQue-SF) designed by Petrides (2009, pp. 85–101) was used. This version has been used in the Spanish context with an internal consistency of Alpha = 0.82 (Cejudo, Díaz, Losada, & Pérez-González, 2016). TEIQue-SF is composed of 30 items with 7 possible responses to each statement ranging from "Completely Disagree" (number 1) to "Completely Agree" (number 7). This test assesses 4 factors: Well-being: 5, 20, 9, 24, 12 and 27, i.e. *I generally don't find life enjoyable*, Self-control: 4, 19, 7, 22, 15 and 30, i.e. *I usually find it difficult to regulate my emotions*, Emotionality: 1, 16, 2, 17, 8, 23, 13 and 28 i.e. *Expressing my emotions with words is not a problem for me*, Sociability: 6, 21, 10, 25, 11 and 26, i.e. *I can deal effectively with people*. Items 3, 18, 14 and 29 contribute only to the global average trait EI score (data not shown). The results obtained in this questionnaire rendered Cronbach's alpha coefficients of

0.91, 0.86, 0.81 and 0.79 respectively. The total Alpha is 0.87. The reliability test-retest (48 h, n = 21) in items showed high results (*Rho* = 0.793 and *Rho* = 0.932 for the lowest and highest respectively, all $p < 0.001$).

#### 2.3.3. Augmented reality game "Pokémon GO"

Pokémon GO has been created by Niantic featuring the original creatures from Nintendo/GAMEFREAK/Creatures. It requires iOS 6.0 or later or Android 4.4 or later (http://www.pokemongo.com/en-us/). The aim is to catch Pokémon, which are virtually superimposed onto physical, real-world surroundings, such as neighbourhood parks, street corners and historical sites, using Smartphone GPS, and level up with them to battle against other players at public 'gyms', which tend to be real world, often highly crowded locations (Anderson et al., 2016). Players attempt to catch Pokémon characters by pointing their phone cameras and tossing 'Pokéballs' at them with their fingers (Fig. 2). Players advance in levels depending on the number of kilometres walked (Serino et al., 2016). Additionally, players can also collect Pokémon 'eggs' and they have to walk certain distances in the real world (2, 5 or 10 km) in order to open them (Anderson et al., 2016).

In order to quantify the level of adherence and amount of PA performed by the adolescents, the level of play acquired by each player (range: 1–30), accumulated points, number of Pokémon captured, distance traveled (km) and daily game time (minutes) were analysed. This data is automatically registered by the Pokémon GO application and can be consulted by each player in real time. To know the satisfaction level with Pokémon GO an *ad hoc* questionnaire composed of seven items of dichotomous response (No, Yes) and exceptionally "I do not know" (*e.g. 1. I consider that Pokémon GO helps me to make new friends*), was administered. The validity of the questionnaire was checked using the Delphi method (Linstone & Turoff, 1975). Items were selected among 20 initial questions. The reliability test-retest (48 h, n = 21) items to items, showed high results (*Rho* = 0.903 and *Rho* = 0.961 for the lowest and the highest respectively, all $p < 0.001$).

#### 2.3.4. Confounders

Age (Esteban-Cornejo et al., 2015), sex (Ardoy et al., 2014), and computer at home as socioeconomic measure (Wainer, Vieira, & Melguizo, 2015), were asked through an *ad hoc* sociodemographic sheet. Maternal educational level, as socio-educational measure, was classified into one of 4 categories (1 = No studies, 2 = Primary school, 3 = Secondary school, 4 = University) used previously by other recent studies (Cadenas-Sanchez et al., 2016; Vanhelst et al., 2016). BMI was controlled in previous studies with similar focus (Bezold et al., 2014). This measure was calculated with weight and height [weight/height ($m^2$)]. An ASIMED® B-type-class III (Spain) and a portable height meter SECA 214 (SECA® Ltd, Germany) were used, respectively. Both measurements were performed on barefoot individuals dressed in light clothing. Finally, to know the weekly MVPA the *Adolescent Physical Activity Measure* questionnaire was used (Prochaska, Sallis, & Long, 2001). Two items were used to assess MVPA: at least one hour a day in the previous week and a typical week. The response scale was the same


**Fig. 2.** Smartphone screen when you want to catch a Pokémon.

for both items: 1 = no days, 2 = one day, 3 = two days, 4 = three days, 5 = four days, 6 = five days, 7 = six days, and 8 = seven days. A mean of the responses to both items was used. Similar to previous studies (Martínez-López et al., 2015), internal consistency of PA items was high (Cronbach's alpha = 0.805).

### 2.4. Procedure

The participants' CP and EI variables were measured at two time points: Second week of August 2016 and after 8 weeks (third week of October 2016), in both groups. The study-intervention duration was 8 weeks (Fig. 1). Pre and post tests were performed in a silent room with individual desks early in the morning (9:00 a.m.), to avoid bias risk and the possible influence of any strange variable. During pre-test, a sociodemographic sheet was completed. Previously at the beginning of the data collection, a written consent was signed by the parents. Furthermore, the researchers prepared all the tests and materials necessary for the research during the first weeks of August. All tests were paper-and-pencil tests and were group-administered. Before each test, students were provided with standardized verbal and written instructions. During testing, one specialized researcher gave instructions and kept track of time, while 2 research assistants each observed the possible doubts and any possible disturbances (*e.g.*, noise outside the classroom, confused students, mistakes in some sheet copies, or students having an empty pen). This study was approved by the Bioethics Committee of the University of Jaén. The design complies with the Spanish regulations for clinical research on humans (*Law 14/2007, July 3rd, Biomedical Research*), with the regulations for private data protection (*Organic Law 15/1999*), and with the principles of the Declaration of Helsinki (2013 version, Brazil).

### 2.5. Data analysis

The comparison of the continuous and categorical variables according to participation in Pokémon GO (CG vs. EG), was carried out through Students' T-test and $\chi^2$, respectively. Tests of normal distribution and homogeneity (Kolmogorov–Smirnov and Levene's) were conducted before analysis. To study the relationship between variables Spearman's correlation was used. The repeated measures ANCOVA 2Group (CG, EG) x 2Time (pre, post) were used to analyse the effects of 8 weeks of a continuous game of Pokémon GO. Each CP and EI measures were used as dependent variables, the group was used as fixed factor, and age, sex, BMI, maternal education, number of computers at home, and MVPA as confounders. *Post-hoc* analysis was adjusted by Bonferroni. Analysis were carried out separately for each dependent variable. For all the analyses, a 95% confidence level was used ($p < 0.05$). The percentage of change between groups after Pokémon GO was calculated as: [(GE post-measurement − GC post-measurement)/GC post-measurement] x 100. The analyses were completed using the statistical software package for social sciences SPSS (v.22 for Windows).

## 3. Results

### 3.1. Descriptive analysis of the results of Pokémon GO and satisfaction of the participants

Table 2 shows the descriptive results in EG after playing Pokémon GO during 8 weeks, as well as the satisfaction of the participants. Players spent a mean of 39.22 ± 28.60 min/day and walked a total distance of 54.33 ± 32.44 km. Boys reached a higher game level than girls (13.43 ± 5.88 vs. 9.09 ± 5.00, $p = 0.002$, respectively), accumulated more points (150233.59 ± 239124.91 vs. 54452.09 ± 60459.70, $p = 0.004$, respectively), and caught a greater quantity of Pokémon (99.74 ± 71.90 vs. 55.30 ± 33.07, $p < 0.001$, respectively). Pokémon GO players said that they played mostly with other players (63.6%, n = 3.59 playmates), that the game could be dangerous (72.7%), and that this activity made them happy and more motivated to go out (54.5% and 56.8%, respectively). The main reason to play was fun among the boys and boredom among the girls (52.3% and 56.5%, $p < 0.001$). Moreover, boys expressed to a greater extent than the girls that this ARG helped to make friends (61.5 vs. 26.1, $p = 0.003$, respectively), that they would be willing to continue playing (70.8 vs. 43.5%, $p = 0.019$, respectively), and to test new versions of the game (86.2 vs. 52.2%, $p = 0.002$, respectively).

### 3.2. Bivariate analysis between anthropometric, sociodemographic and cognitive-emotional measures

Table 3 shows the results of Spearman correlation analysis between the studied variables. Age was positively related with selective attention and concentration (*Rho* = 0.293 and 0.278, respectively, both $p < 0.01$). Sex (0 = girls, 1 = boys) was positively related to mathematical calculation and sociability (*Rho* = 0.314, $p < 0.01$ and 0.248, $p < 0.05$, respectively). BMI was negatively related with memory, and maternal education level was associated with more computers at home, higher linguistic reasoning and lower sociability (*Rho* = 0.327 for the greatest, $p > 0.01$). Memory, selective attention, concentration, mathematical calculation and linguistic reasoning variables were all intercorrelated (*Rho* = 0.414 for the highest, all $p < 0.001$). Emotionality was negatively associated with memory and linguistic reasoning, and positively with self-control (*Rho* = 0.332 for the highest, $p < 0.01$). Sociability was negatively associated with concentration and linguistic reasoning, and positively with self-control (*Rho* = 0.283 for the highest, $p < 0.01$).

**Table 2**
Results of experimental group after 8 weeks playing Pokémon GO and opinion of players. Values are showed as mean and standard deviation or percentage.

| Variable | | All (n = 87) | Girls (n = 23) | Boys (n = 64) | p - Value |
|---|---|---|---|---|---|
| Game level | | 12.30 ±5.96 | 9.09 ±5.00 | 13.43 ±5.88 | 0.002 |
| Accumulated points | | 125199.79 ±211612.31 | 54452.09 ±60459.70 | 150233.59 ±239124.91 | 0.004 |
| Captured Pokémon (n) | | 88.12 ±66.82 | 55.30 ±33.07 | 99.74 ±71.90 | <0.001 |
| Distance traveled (Km) | | 54.33 ±32.44 | 52.26 ±33.06 | 55.07 ±32.45 | 0.723 |
| Game time (minutes/day) | | 39.22 ±28.60 | 45.09 ±37.96 | 37.14 ±24.48 | 0.356 |
| Group of simultaneous players (n) | | 3.59 ±2.18 | 2.67 ±1.77 | 3.86 ±2.23 | 0.067 |
| Game reasons | I do not know | 2 (2.3) | 0 (0) | 2 (3.1) | <0.001 |
| | Doredom | 18 (20.5) | 13 (56.5) | 5 (7.7) | |
| | Enjoyment | 42 (47.7) | 8 (34.8) | 34 (52.3) | |
| | Friendship | 10 (11.4) | 0 (0) | 10 (15.4) | |
| | PA | 16 (18.2) | 2 (8.7) | 14 (21.5) | |
| Way of displacement | Alone | 32 (36.4) | 11 (47.8) | 21 (32.3) | 0.188 |
| | Accompanied | 56 (63.6) | 12 (52.2) | 44 (67.7) | |
| I consider that Pokémon GO helps me to make friends | No | 42 (47.7) | 17 (73.9) | 25 (38.5) | 0.003 |
| | Yes | 46 (52.3) | 6 (26.1) | 40 (61.5) | |
| I consider that playing Pokémon GO may be dangerous | No | 24 (27.3) | 8 (34.8) | 16 (24.6) | 0.249 |
| | Yes | 64 (72.7) | 15 (65.2) | 49 (75.4) | |
| I think that playing Pokémon GO makes me more happy | No | 40 (45.5) | 8 (34.8) | 30 (46.2) | 0.243 |
| | Yes | 48 (54.5) | 15 (65.2) | 35 (53.8) | |
| When I play Pokémon GO, I feel more motivated to go outside | No | 38 (43.2) | 10 (43.5) | 30 (46.2) | 0.510 |
| | Yes | 50 (56.8) | 13 (56.5) | 35 (53.8) | |
| My parents prefer that I play Pokémon GO because I practice more physical activity | No | 38 (43.2) | 11 (47.8) | 27 (41.5) | 0.870 |
| | I do not know | 42 (47.7) | 10 (43.5) | 32 (49.2) | |
| | Yes | 8 (9.1) | 2 (8.7) | 6 (9.2) | |
| Are you willing to continue playing Pokémon GO? | No | 32 (36.4) | 13 (56.5) | 19 (29.2) | 0.019 |
| | Yes | 56 (63.6) | 10 (43.5) | 46 (70.8) | |
| Are you willing to test new versions of Pokémon GO? | No | 20 (22.7) | 11 (47.8) | 9 (13.8) | 0.002 |
| | Yes | 38 (77.3) | 12 (52.2) | 56 (86.2) | |

PA = Physical activity.

### 3.3. ANCOVA analysis of the effect of Pokémon GO on cognitive performance and emotional intelligence variables

Figs. 3 and 4 show the results of ANCOVA analysis where each cognitive and emotional measure was used as dependent variable, the group (CG vs. EG) as fixed factor, and age, sex, BMI, maternal education level, number of computers at home, and MVPA as confounders. Results in memory (Fig. 3a) did not show any main or interaction effects (all $p > 0.05$). Nevertheless, selective attention showed a significant group effect $F(1,165) = 7.301$, $p = 0.008$, *partial* $\eta^2 = 7.301$, $1\text{-}\beta = 0.766$. After 8 weeks, selective attention was 13.26% higher in EG than in CG (187.87 ± 35.45 vs. 166.69 ± 45.83, $p = 0.003$, Fig. 3b). Finally, results for concentration (Fig. 3c) showed a main effect of time ($p = 0.012$), an interaction effect group x time $F(1,165) = 5.862$, $p = 0.017$, partial $\eta^2 = 0.034$; $1\text{-}\beta = 0.673$, and a main effect of group $F(1,165) = 9.589$, $p = 0.002$, partial $\eta^2 = 0.055$, $1\text{-}\beta = 0.868$. EG significantly increased concentration after 8 weeks playing Pokémon GO (Pre = 163.59 ± 55.34 vs Post = 192.51 ± 36.97, $p < 0.001$). In addition, concentration in Pokémon GO players had increased by 19.40% compared to non-players at the end of the study (192.51 ± 36.97 vs. 161.22 ± 48.60, respectively, $p < 0.001$). Results in mathematical calculation and linguistic reasoning did not show any main or interaction effect (all $p > 0.05$, Fig. 4).

Results in EI are shown in Fig. 5. Well-being (Fig. 5a) and self-control (Fig. 5b) did not show any main or interaction effect (all $p > 0.05$), and emotionality (Fig. 5c) only showed a main effect of time ($p = 0.031$). However, in sociability (Fig. 5d) was found a main effect of group $F(1,165) = 9.215$, $p = 0.003$, partial $\eta^2 = 0.053$, $1\text{-}\beta = 0.855$, and an interaction group x time $F(1,165) = 6.307$, $p = 0.013$, partial $\eta^2 = 0.037$, $1\text{-}\beta = 0.704$. After 8 weeks, sociability scores in EG significantly increased compared to the pre measure (4.76 ± 1.06 vs 4.40 ± 0.71, $p = 0.038$). It was also found that the sociability score was 9.87% higher in EG than in CG at the end of the study (4.76 ± 1.06 vs. 4.40 ± 0.71, respectively, $p = 0.003$).

## 4. Discussion

This study analysed the effect of 8 weeks of ARG Pokémon GO on CP and EI in Spanish adolescents between 12 and 15 years. It was also proposed to describe the sociodemographic characteristics associated with Pokémon GO players and their degree of satisfaction with the game. Adolescents who have systematically practised Pokémon GO for 8 weeks have significantly increased their selective attention and concentration levels compared to non players, independently of age, sex,

**Table 3**
Bivariate correlation of Spearman between the studied variables ($n = 190$).

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1.Age | 1 | | | | | | | | | | | | | |
| 2.Sex (0 = girls, 1 = boys) | 0.164 | 1 | | | | | | | | | | | | |
| 3.BMI | 0.127 | -0.035 | 1 | | | | | | | | | | | |
| 4.Maternal education level | 0.009 | -0.180 | -0.186 | 1 | | | | | | | | | | |
| 5.Number of computer at home | 0.047 | 0.000 | -0.147 | 0.327** | 1 | | | | | | | | | |
| 6.MVPA | -0.097 | 0.122 | -0.138 | -0.269 | -0.153 | 1 | | | | | | | | |
| 7.Memory | -0.046 | 0.069 | -0.220* | 0.156 | 0.102 | -0.291 | 1 | | | | | | | |
| 8.Atenttion | 0.293** | 0.090 | -0.103 | 0.071 | 0.033 | -0.283 | 0.281** | 1 | | | | | | |
| 9.Concentration | 0.278** | 0.060 | -0.155 | 0.126 | 0.032 | -0.279 | 0.312** | 0.918** | 1 | | | | | |
| 10.Mathematical calculation | 0.150 | 0.314** | -0.155 | 0.148 | -0.067 | -0.134 | 0.321** | 0.375** | 0.353** | 1 | | | | |
| 11.Linguistic reasoning | 0.019 | -0.135 | -0.049 | 0.278** | 0.083 | -0.273 | 0.414** | 0.408** | 0.404** | 0.379** | 1 | | | |
| 12.Wellbeing | -0.111 | 0.084 | -0.045 | -0.067 | 0.022 | -0.031 | 0.129 | 0.197 | 0.094 | 0.041 | -0.006 | 1 | | |
| 13.Self-control | 0.170 | 0.104 | 0.197 | -0.121 | 0.029 | 0.059 | 0.070 | 0.053 | 0.031 | 0.024 | 0.132 | 0.033 | 1 | |
| 14.Emotionality | 0.058 | 0.139 | 0.052 | -0.170 | 0.127 | 0.296 | -0.222* | -0.152 | -0.115 | -0.170 | -0.247* | 0.048 | 0.332** | 1 |
| 15.Sociability | -0.114 | 0.248* | 0.192 | -0.214* | -0.189 | 0.156 | -0.023 | -0.189 | -0.246* | -0.026 | -0.283** | 0.168 | 0.232* | 0.200 |

** Correlation is significative at level 0.01 (bilateral). * Correlation is significative at level <0.05 (bilateral). BMI = Body mass index. MVPA = Moderate to vigorous physical activity.

socioeconomic status, maternal education, BMI and MVPA. Effects on the different EI factors have been similar in CG and EG, except for sociability levels that significantly increased in EG. The results have also shown that players play 40 min/day, although only 18.2% of them play to increase their daily PA practice. Boys play more for fun and girls to combat boredom. In fact, the boys became more involved in the daily practice of the game, accumulating more points, and reaching a higher level than the girls. Boys and girls have practised mostly accompanied by other players, and most of them feel more happy and motivated to go outside. These results suggest that the App Pokémon GO could be used in school and family contexts to increase the daily amount of MVPA, to stimulate important CP variables such as selective attention or concentration, and to take advantage of the collective nature of the game to enhance socialization in adolescents.

After 8 weeks, the young people playing Pokémon GO showed a higher selective attention (13.26%) and concentration (19.40%) than those who did not play. Even though exergames led to physiological improvement (Baranowski, 2015; Gao & Xiang, 2014; Höchsmann, Schüpbach, & Schmidt-Trucksäss, 2016), their specific effects on CP variables are almost unknown (Granic, Lobel, & Engels, 2014). Some years ago, Boot, Kramer, Simons, Fabiani, and Gratton (2008) and Quiroga et al. (2009) showed that some passive video games positively affect general intelligence. However, there are other studies showing that passive video games have negative effects such as impulsiveness or attentional problems in adolescents (Gentile, Swing, Lim, & Khoo, 2012). Furthermore, it has been shown that to improve specific aspects of CP, it is not enough to play passive video games, and the games need to be active. For instance, Best (2012) studied the differences between physically active video games versus sedentary video activities in a sample of children aged 6–10 years, and he found that exergaming enhanced executive functions through children's speed in resolving interference from conflicting visuospatial stimuli. Flynn et al. (2014) showed in young people aged 10–16 years, the positive effects of five 30-minute exergame play sessions on executive functions. In this line, two studies analysed the acute effect of exergame on executive functions in two special populations. Staiano, Abraham, and Calvert (2012) found that overweight and obese adolescents who played competitive exergames improved in executive function skills more than did those in the cooperative exergame condition and the non-playing CG. Whilst Anderson-Hanley, Tureck, and Schneiderman (2011) tested that playing an exergame for 20 min (either Dance Dance Revolution or a cybercycle game) could bolster executive functions in children and adolescents (aged 8–21 years) diagnosed with Autism Spectrum Disorder. More recently, Best (2013) created an explanatory model where he showed how exergames could benefit cognition, and especially executive functions in youth, through their positive effect on PA, fitness, motor skills and on the cognitive skills required by the game. Some of these skills that young people can develop with the use of exergames are spatial awareness, understanding cause-effect relationships, correct manipulation of the smartphone, computer or video console, appropriate responses to visual feedback, action planning, understanding spatial limitations, creation of a cognitive map of body movements in relation to the game, or self-improvement of attention-concentration, all of them determinants for better academic performance at school (Staiano & Calvert, 2011). In fact, an intervention programme based on the exergame Dance Dance Revolution during recess, in sessions of 30 min, 3 times per week during 1 year, improved children's academic performance in an important school subject such as maths (Gao, Hannan, Xiang, Stodden, & Valdez, 2013). However, adolescents who have systematically practised Pokémon GO for 8 weeks have not increased memory, mathematical calculation or linguistic reasoning with regard to their peers. Contrary to our results, previous studies associate a higher PA practice with better working memory (Chaddock-Heyman et al., 2014), arithmetic skills (Moore et al., 2014), or language processing (Scudder et al., 2014). Morales, González, Guerra, Virgili, & Unnithan. (2011) found positive associations of fine-motor skill an ability highly related with Smartphone use with linguistic and mathematical skill. Therefore, it is possible that the physical and mental stimulus needed to significantly affect variables such as memory, mathematical calculation or linguistic reasoning would require more than 8 weeks of ARG Pokémon GO.

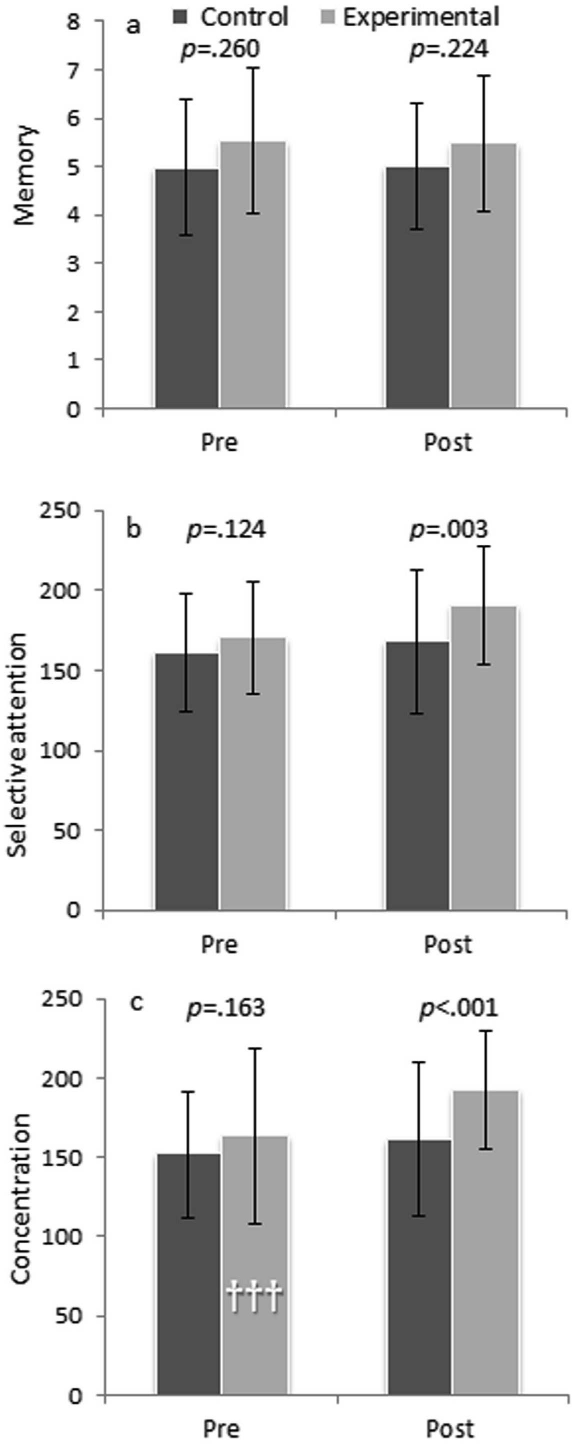


**Fig. 3.** ANCOVA analysis in memory, selective attention and concentration after 8 weeks playing Pokémon GO in adolescents. †††$p < 0.001$.

The effects of PA promoted by Pokémon GO on selective attention and concentration could be explained through several mechanisms. Firstly, PA practice may improve the microstructure of the white matter of the brain, increasing the speed and efficiency of neuronal activity (Chaddock-Heyman et al., 2014), and may promote angiogenesis, increasing capillary density and brain vascularization (Adkins, Boychuk, Remple, & Kleim, 2006). Moreover, PA stimulates the hippocampus Fndc5 gene expression through a PGC-1α/Errα transcriptional complex. This elevated Fndc5 boosts Brain-Derived Neurotrophic Factor

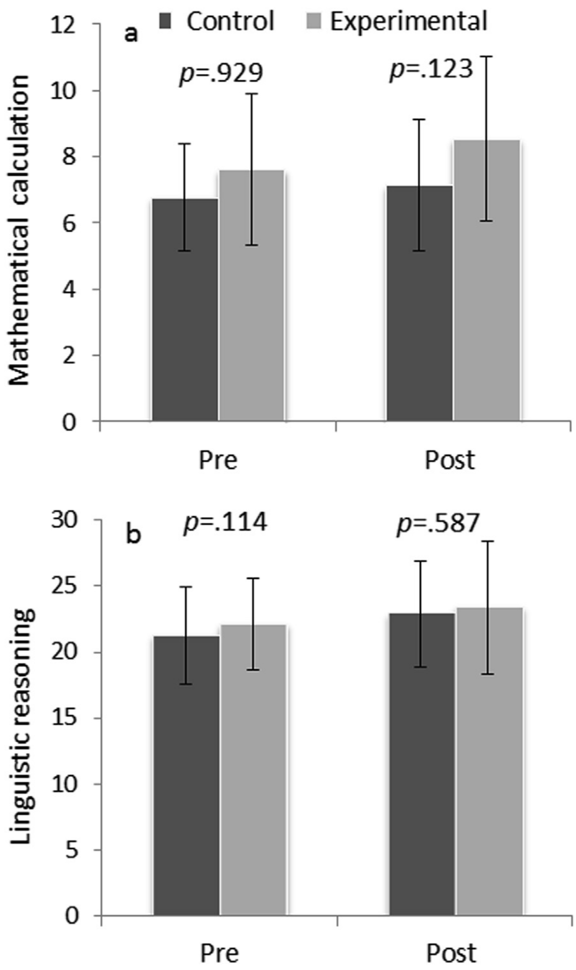


**Fig. 4.** ANCOVA analysis in mathematical calculation and language ability after 8 weeks playing Pokémon GO in adolescents.

[BDNF] (Chang & Etnier, 2015). Another hypothesis is that PA induces the accumulation of a ketone body (D-β-hydroxybutyrate) in the hippocampus, where it serves both as an energy source and an inhibitor of class I histone deacetylases to specifically induce BDNF expression (Sleiman et al., 2016). BDNF is the master regulator of nerve cell survival, differentiation and plasticity in the brain, which improves cognitive function (Piepmeier & Etnier, 2015). In addition, PA may improve the spinal cord function, causing synaptogenesis and the reorganization of movement representations within the motor cortex (Adkins et al., 2006). PA increases the level of brain neurotransmitters such as serotonin or norepinephrine, which facilitate information processing and CP control (Lojovich, 2010).

On the other hand, after 8 weeks, Pokémon GO players had better social relationships with peers (9.87%) than those who did not play. These results are similar to those found by Granic et al. (2014) and Hogan et al. (2015) concluding that this ARG may be an important means of socialization in young people. Another study carried out with preadolescents aged 9–12 years showed that young people prefer multiplayer and group exergames instead of solitary exercise, due to the social interaction (Chin, Jacobs, Vaessen, Titze, & van Mechelen, 2008). In this sense, Serino et al. (2016) indicated that Pokémon GO contains an important social aspect that enhances the users' experiences and creates a sense of unity among players from any culture, age and sex. These authors indicate that one of the best features of this ARG is that players can play against nearby neighbours, potentially initiating conversation among them and others who share a common interest in this game, fostering sociability. Furthermore, Pokémon GO also allows users to play together while they are not in close proximity, so friends can compete even if they are in distant geographic locations. A study carried out among British adolescents showed that loneliness is one of the most linked variables to emotional skill deficits (Wols, Scholte, & Qualter, 2015). More in depth, Tateno et al. (2016) and Kato et al. (2016) concluded that Pokémon GO may encourage going out to play for young people with severe social withdrawal, called hikikomori a Japanese psychopathological syndrome of social isolation, which is based on avoiding any non-virtual contact for more than 6 months, which typically begins in childhood as school refusal during more than 30 days per year, caused by psychological factors such as fear, anxiety, and a sense of rejection, and which persists into adulthood if it is not treated. At the same time, our results show that both boys and girls have played mostly accompanied by other players, and

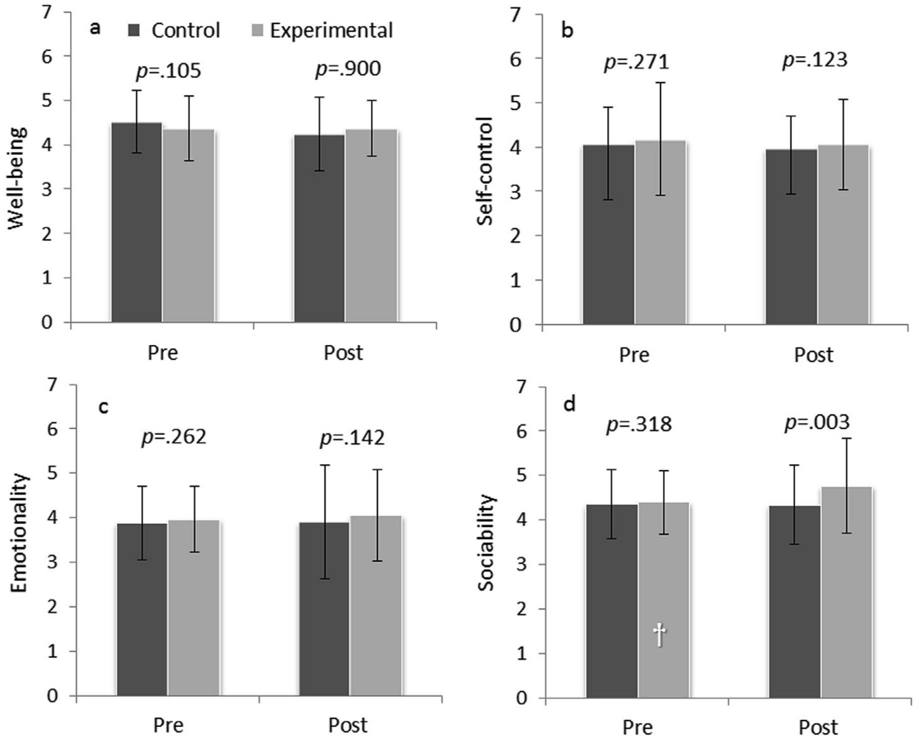


**Fig. 5.** ANCOVA analysis of emotional intelligence (Well-being, self-control, emotionality, y sociability) after 8 weeks playing Pokémon GO in adolescents. †$p < 0.05$.

they are more happy and motivated to go outside. Thus, Pokémon GO may promote social culture through visiting famous buildings, monuments and cultural places in the company of friends or playmates (Serino et al., 2016; Smith, 2016). Nevertheless, there are not only social benefits, news articles also highlight potential social dangers to players by irresponsible gameplay (Joseph & Armstrong, 2016; Sharma & Vassiliou, 2016; Wagner-Greene et al., 2017). For example, this ARG may increase the risk of injuries due to walking distractedly, abduction by strangers, spatial disorientation, addiction, or social violence (McCartney, 2016; Raj, Karlin, & Backstrom, 2016; Serino et al., 2016; Wagner-Greene et al., 2017). Furthermore, Ayers et al. (2016) and Barbieri et al. (2017), found that Pokémon GO is a hazardous distraction for drivers and pedestrians and may increase the risk of traffic accidents. Ayers et al. (2016), showed that 33% of a random sample of 4000 Tweets indicated that a driver, passenger or pedestrian was distracted by Pokémon GO and that 80% of Tweets indicated a person was simultaneously playing and driving. On the other hand, Barbieri et al. (2017), analysed a case report with a man who crossed a street in red traffic lights while playing Pokémon GO, and was hit by a car. Thus, these kinds of ARG could have a significant risk to users who play while walking or driving in city streets. Finally, our data have not shown significant changes in Pokémon GO adolescent players regarding well-being, self-control and emotionality. A recent systematic review has shown that exergames have positive effects on self-concept or well-being (Joronen, Aikasalo, & Suvitie, 2016). In this line, Azevedo et al. (2014) found a significant effect of 12-month follow-up exergaming dance intervention on psychological well-being that increases positive emotions, satisfaction with life and the sense of emotional balance. It is possible that 8 weeks playing Pokémon GO is insufficient to show positive effects on these psychological variables, because most of the studies have shown that PA practice significantly improves them (Martínez-López et al., 2015; Padilla-Moledo, Ruiz, Ortega, Mora, & Castro-Piñero, 2012; Ruiz-Ariza et al., 2015).

Data from this study show that players walked 54 km in 8 weeks. According to McCartney (2016), the first player in the United Kingdom to capture all the Pokémon walked 225 km and lost around 12 kg of weight in just 3 weeks. Baranowski (2016) reported that substantial numbers of Pokémon GO players were willing to be physically active (i.e. substantial walking) for long periods of time (newspaper stories reported some players were chasing Pokémon for hours at a time). Howe et al. (2016) and Althoff, White, and Horvitz (2016) associated Pokémon GO with a significant increase in the daily average steps, by 955 and 1473 additional steps/day, respectively. In fact, players can walk 2, 5 or 10 km to open different Pokémon "*eggs*" acquired from PokéStops (Anderson et al., 2016). Thus, at more km walked, better level in the game (Anderson et al., 2016; Serino et al., 2016). On the other hand, a decade ago, Lanningham-Foster et al. (2008) demonstrated that when traditionally sedentary screen time is converted into active screen time, energy expenditure was more than double. In this way, Pokémon GO maintains the essence of traditional video games but also encourages the motivation of the participants towards the practice of outdoor MVPA (Clark & Clark, 2016; LeBlanc & Chaput, 2016). Subsequently, players were found to have reduced sedentarism (Nigg et al., 2016), enhance cardiovascular fitness (Sharma & Vassiliou, 2016), decrease obesity (Smith, 2016), reduce the type 2 diabetes burden (McCartney, 2016), benefit from a positive impact on mood (Serino et al., 2016), or reduced depression and anxiety (McCartney, 2016). Our findings reveal that boys play more for fun and girls to combat boredom. Boys spend more time per day playing, accumulate more points and reach a higher game level than girls. These data differ from Howe et al. (2016) who did not find differences with regard to the playing time of Pokémon GO or the increase of daily PA according to sex, but agree with the results found by Limperos & Schmierbarch (2016), who suggest that longer time spent playing exergames predicts a feeling of enjoyment and a greater intention to continue playing in the future. Thus, boys may feel greater enjoyment than girls due to the higher feedback received from the challenges, prizes and game levels that Pokémon GO offers (Lyons, 2015). The above is consistent with the current evidence that boys are more attracted to the practice of PA than girls (Ruiz-Ariza, Ruiz, De la Torre-Cruz, Latorre-Román, & Martínez-López, 2016a,b). Indeed, 50% of Spanish adolescent boys achieve the recommendations of 60 min/day of practice of PA versus 14% of girls (Mielgo-Ayuso et al., 2016). Hence, boys in the present study could feel a greater motivation towards the practice of PA required in Pokémon GO than girls.

In spite of everything written here, this study has some limitations. Pokémon GO does not record intensity of PA, nor does it differentiate the km that have been made on foot or by other means of transport such as bicycle. The lack of studies studying the relationship between Pokémon GO and cognitive or EI variables, made the comparison of our results difficult. However, the wide knowledge about the influence of PA on these variables facilitated the discussion. We do not know the acute effect on cognition or EI, nor have we obtained additional information about the possible risks during the execution of Pokémon GO. The study mixed summer and school periods for pre-post data collection. We also do not know if outside the school hours, participants have manipulated the App. Another limitation is the season and weather, which could be decisive to practise outdoor PA. Finally, Pokémon GO could need a more expensive and higher level Smartphone, and some teenagers may not have this economic possibility.

### *4.1. Educational implications*

Two recent systematic reviews carried out by Esteban-Cornejo et al. (2015) and Ruiz-Ariza et al. (2017), showed that a greater practice of PA was associated with a better CP and academic performance in adolescents. More specifically, two intervention studies showed a strong positive effect on attention and concentration after 10 min of coordinative exercise (Budde, Voelcker-Rehage, Pietraßyk-Kendziorra, Ribeiro, & Tidow, 2008) and 20 min of aerobic moderate exercise (Hogan et al., 2013). The main physical feature of Pokémon GO, such as walking, was also associated with higher attention levels in the d2 test (Van Dijk, De Groot, Van Acker, Savelberg, & Kirschner, 2014) and greater academic performance (Ruiz-Ariza, de la Torre-Cruz, Suárez-Manzano, & Martínez-López, 2017), especially in adolescent girls. Further, Haapala et al. (2014) and Ruiz et al. (2010) showed, among Finnish and Spanish young people respectively, that extracurricular PA does not disserve CP, but rather benefits it. The playing features of Pokémon GO make it an efficient tool to gamify the teaching-learning process in any subject (Domínguez et al., 2013). In particular, Pokémon GO has the potential to raise motivation and adherence to systematic PA practice from an educational context (Serino et al., 2016). For example, Pokémon GO could be used as an extracurricular activity complementary to the traditional didactic units proposed in Physical Education (Clark & Clark, 2016; Staiano & Calvert, 2011). Moreover, Pokémon GO could adapt to some novel didactical initiatives that have proposed educational videogames with interactive systems based on a Massively Multiplayer Online Role-Playing Game, increasing sociability in secondary school (González-González & Blanco-Izquierdo, 2012), or to gesture interactive game-based learning to improve children's learning performance combining gesture-based computing technology and a cooperative game-based learning model (Hainey, Connolly, Boyle, Wilson, & Razak, 2016; Hsiao & Chen, 2016). Therefore, a suitable didactic use of Pokémon GO based on these innovations could have a large number of educational applications with the aim of improving key academic variables of CP and EI.

## 5. Conclusion

It is concluded that adolescents aged 12–15 years that played Pokémon GO during 8 weeks show a higher level in selective attention, concentration and sociability than those who did not play, independently of age, sex, socioeconomic status, maternal education, BMI and MVPA. Pokémon GO adolescent players played an average of 40 min/day during 8 weeks playing this ARG. Boys play more often for fun and girls to combat boredom. Boys became more involved in daily game practice, accumulating more points, and reaching a higher level than girls. Boys and girls practised mostly accompanied by other players, are more happy and motivated to go out, and they would be willing to test new versions of the game. However, a lack of evidence shows that more randomized controlled trial studies should be performed analysing Pokémon GO compared to traditional teaching approaches and educational methods to ascertain if Pokémon GO is a useful viable cognitive and social approach in adolescents. Further studies are also required to perform comparisons between single and collaborative play and to identify the pedagogical benefits through some subjects such as Physical Education.

## Declaration of interest

The authors declare no competing interest.

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