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"DANCE DANCE" EDUCATION. A REAL "REVOLUTION" FOR THE CLASSROOM?

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Abstract. Introduction: The current society is in constant evolution in search of new educational methodologies that allow a better integral formation of the students. These should be attractive and motivational while allowing the improvement of the cognitive variables of the students. Therefore, the purpose of this review was to analyze the effect of Active Video Games or Exergame (EX) Dance Dance Revolution (DDR) on cognitive and academic performance in children and adolescents. **Method:** A literature research was conducted in four databases (Pubmed, Web of Science, Scopus and ProQuest, n = 265). The search was carried out in the last ten years (January 2007 / September 2017). **Results:** A total of 3 intervention studies were included in the review with a participation of 273 children and adolescents. The results show that after the practice of the DDR Exergame, the students improved their cognitive activity. They also obtained other physiological benefits derived from their practice. **Discussion:** These results reflect that the promotion of programs through EX could have great potential for cognitive and academic development at this stage of education. In addition, they would allow the development of healthy habits of physical activity, the increase of student motivation and a better socialization.
Keywords: Exergames, Dance Dance Revolution, Cognition, Academic Performance, Children.

"DANCE DANCE" EDUCACIÓN. ¿UNA VERDADERA "REVOLUCIÓN" PARA EL AULA?

Resumen. **Introducción:** La sociedad actual se encuentra en constante evolución en búsqueda de nuevas metodologías educativas que permitan una mejor formación integral del alumnado. Estas deben ser atractivas y motivadoras a la vez que permitan la mejora de las variables cognitivas del alumnado. Por ello, el objetivo de

esta presente revisión fue analizar el efecto del Videojuego Activo o Exergame (EX) Dance Dance Revolution (DDR) sobre el rendimiento cognitivo y académico en niños y adolescentes. **Método:** Se realizó una búsqueda bibliográfica de la literatura en cuatro bases de datos (Pubmed, Web of Science, Scopus y ProQuest, n = 265). La búsqueda se realizó en los diez últimos años (enero 2007/septiembre 2017). **Resultados:** Un total de 3 estudios de intervención fueron incluidos en la revisión con una participación de 273 niños y adolescentes. Los resultados muestran que tras la práctica de DDR, el alumnado mejoró su actividad cognitiva. Además obtuvieron otros beneficios a nivel fisiológico derivados de su práctica. **Discusión:** Estos resultados reflejan que la promoción de programas mediante EX podría tener un gran potencial para el desarrollo cognitivo y académico en esta etapa educativa. Además, permitirían el desarrollo de hábitos saludables de actividad física, el aumento de la motivación del alumnado y una mejor socialización.
Palabras clave: Video juegos activos, Dance Dance Revolution, Cognición, Rendimiento Académico, Niños.

Introduction

Dance Dance Revolution (DDR) appears at the end of the 90s as a pioneer of the dance simulators in video games. The game's objective is to step in the arrows, which are displayed as a cross on the dance platform, following the music's rhythm and the visual pattern that is shown on the screen (Norris et al, 2016). This video game modality is included with exergaming (EX), and is the one with the furthest expansion. Such games require from participants who are physically active or who exercise in order to play (Anderson, Steele, O'Neill and Harden, 2016; Clark & Clark, 2016) The EX interpret body movements by transferring the movement into the device, which produces a motor connection between the participant and the application. This kind of video game allows to enhance the player's physical activity (PA) level (Nukkala, Kalermo and Jarvilehto, 2014), the caloric expenditure (Barnett, Cerin and Baranowsky, 2015) and improves the coordination (Smits-Engelsman, Jelsma and Ferguson, 2016). Moreover, they allow to promote learning through a series of challenges with multiple experience levels, therefore favoring social relationship between equals (Roemmich, Lambiase, McCarthy, Feda and Kozlowski, 2012).

The EX games, like DDR, have been established as a video game stereotype that seek to decrease a sedentary lifestyle in support of a healthy one. This kind of video game involves the movement and helps to increase the PA's levels, just enough as to favor a good health and physical condition. Currently, the EX are present at the society's daily routine, especially amongst its youngest population. This stage is considered as the most critical period, for it is when the sports-physical practice is greatly diminished (Ruiz et al, 2011). Nowadays, recommendations for PA's practice to develop a healthy lifestyle are, at least, 60 minutes of moderate-high intensity exercise every day, that include activities aimed at bone and muscular strengthening. Nevertheless, the youngest population does not meet the minimum quantities (Baskin, Thind, Affuso, Gary, LaGory y Hwang, 2013). Enhancing the PA levels could compensate for the high sedentary levels which are resulting in a decrease in the motor skills as well as in an increase in physical inactivity, which consequently leads to health problems such as overweight and obesity (Stodden et al, 2008). Any increase in the PA, especially when sedentary behavior is replaced, it is beneficial for the social, physical and mental health. But can the EX like the DDR influence the academic and cognitive development?

Nowadays, plenty of studies support this idea, even though just few of them focus on cognition. There are empirical evidences indicating that EX, thanks to their characteristics related with the PA, have a positive influence on cognition, which is divided into the cognitive performance (CP) and the academic performance (AP) (Benzing y Schmitd, 2017; Diamond, 2013, Ruiz-Ariza, Grao-Cruces, Loureiro, & Martínez-López, 2017). Memory,

selective attention, concentration, and numerical-linguistic reasoning are among the most important variables in CP (Esteban-Cornejo, Tejero-González, Sallis, & Veiga, 2015; Ruiz et al, 2010; Ruiz-Ariza et al, 2017). Regarding the AP, it refers to the a student's successful academic performance during the personal academic period, the student is generally assessed according to a grade point average in a certain school subject (Haapala, 2013; Ruiz-Ariza, Ruiz, de la Torre-Cruz, Latorre-Román y Martínez-López, 2016). According to the PISA study that was performed during 2015 (Ministry of Education, Culture and Sport, 2016) Spanish teenagers are on the OCDE's average in terms of the AP results. This factor is also due to that the state members' average has dropped. Because of that, the EX might have a positive influence and might help to establish educational strategies to promote cognition. Accomplishing that young people get involved in the PA's active practice by using the EX is not only physically attractive, but they are also motivating and compromising activities, cognitively speaking.

This review focuses on young people between 6 and 18 years old. Furthermore, the cognitive variables at these ages are easily modifiable, since they much depend on parental support (De la Torre-Cruz et al, 2014) and on social support (Hogan et al, 2015). Moreover, young people have a high brain plasticity degree, which is decisive to promote the CP and improve the AP, guarantee an appropriate behavior and favor the future social success (Esteban-Cornejo et al, 2015; Ruiz-Ariza et al, 2017). Thus, knowing the relationship an EX such as DDR and cognition may be useful in order to innovate in motivating educational interventions that are oriented towards increasing the PA levels. As well, it could be a complement for the physical education classes, the playground, or the classroom teaching, for the school time comprises many hours which are dedicated to sedentary activities (Norris et al, 2016).

Basing on the aforementioned, the aim of this systematic review is to conduct a research on the link between the use of DDR and the different cognitive parameters of children and young people who are 6-18 years old. Additionally,this paper reviewed possible co-variables like the gender, and the BMI which can measure the relationship between DDR and cognition.

Methodology

In order to select the papers relates to the topic, an exploratory search was conducted on the following data bases: PubMed, Web of Science, Sportdiscus, ProQuest. The search terms were:

- Active video games, exergames, dance dance revolution.
- Cognition, psychological, academic performance.
- Adolescents, children, teenager.

Every study that has been included in this paper had to meet the following searching criteria:

- The study population suffered from no disabilities.
- The EX in use must be DDR and the used cognitive measures must be clearly stated.
- The study population has to be 6-18 years old.
- The studies can either have been in Spanish or English.

- Studies need to have been performed within the last 10 years (2007/2017).

To observe the flowchart regarding the selected articles, see Figure 1.

Number of participants in the selected studies ranged between 12 and 208. The total number of participants was 273, subjects who were between 8 and 21 years old. The age of the participants was extended until 21 years old because one of the selected articles analyzed a sample that was between 8 and 21 years old, the youngest participants being aged under 10, therefore, lacking of interest for the the present paper's final results and discussion.

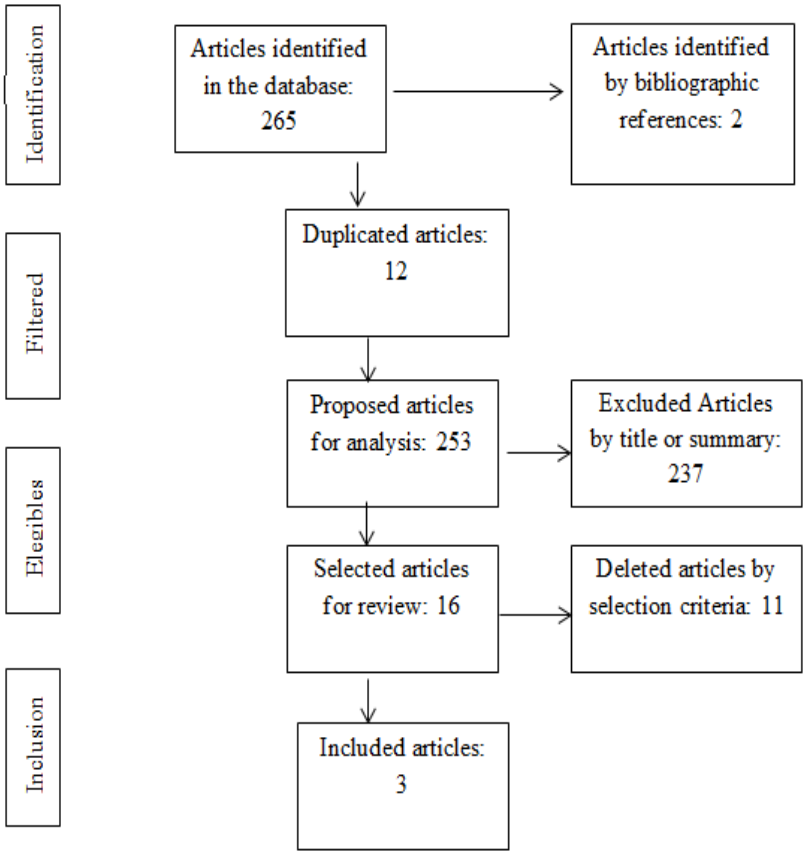

Figure 1. Articles' flow during the searching process

Results

The searching results flow through the review process is shown in Figure 1. The initial search resulted in 265 studies in total. After eliminating the duplicates and the articles excluded because of the title, abstract or age, language or design as well as for not meeting our criteria, 16 articles were retrieved in total. At last, 3 were the included articles in the systematic review (Anderson *et al*, 2011; Gao *et al*, 2013a; Gao *et al*, 2013b).

Table 1
Description of the articles included in the study

Author	Objective	Design, co-variables and duration	Population / Age / Country	Exergame	Cognitive Measures	Results
Anderson *et al*, (2011).	Two pilot studies explored the potential cognitive and behavior benefits from the exergaming.	Intervention / Participants were exposed to the control and the experimental condition in a A-B / --- / 20 min sequential design.	Pilot I: N = 12 / 10 to 18 years old / Pilot II: N = 10 / 8 to 21 years old / United States	Study I: Non-randomized control session, video that lasts for 20 minutes of a previously recorded school talent program. Exergaming session DDR for 20 min. Study II: (Non-randomized) control session, 20 minutes length of a school talent program which was previously recorded. Exergaming session cybernetic cycling for 20 min	Digit Span Forward and Backward, Color Trails Test and The Stroop task.	A significant interaction was found, which proved an improvement after the exergaming, bot the DDR and the cybernetic cycling, in comparison to the control condition, for repetitive behaviors and a measure of the executive functions (Study I P<0,001).
Gao et al, (2013a).	Examining the impact of exercising by making use of DDR, on the latin children's physical ability and academic performance.	Intervention/ gender and age/ 2 years	N = 208 / 10 to 12 years old / United States	3 non-randomized groups (a 4th grade group Intervention based on 15 min of DDR and other 15 min during which they got engaged in school activities during the school day / 2 groups to compare with (3rd and 5th graders) participated in the non-structured and conventional playground time, which is walking and playing)	Utah Criterion Referenced Test	Significant differences were observed between the intervention and the comparison groups in the differences in the 1 mile scores and the scores on math in year 1 and year 2 (P = 0,01). Results showed as well clear distinctions between the intervention before the comparison group's scores in the 1 mile race for the 3rd grade students (P = 0,01). Furthermore, the changes in the BMI groups prior to the children's test and post-test differed (P = 05) only during the first intervention's year.
Gao et al, (2013b).	Comparing the children's PA levels, the auto-efficiency and the enjoyment when experiencing exergaming-dance DDR and aerobics dance in the physical education class.	Intervention / --- / 9 months	N = 53 / 10 to 11 years old / United States	Non-randomized groups One group plays DDR and the other is focused on aerobics dance. After 15 min, the groups switched activities and continued with them for another 15 min.	Self-efficacy Likert-type scale	Children exercised at a rather moderate intensity PA (p<0,01) in aerobics dance than they did in DDR Moreover, children reported a greatly higher auto efficiency (p<0,001) and enjoyment (p<0,01) in DDR than in aerobics dance.

Note: EX = Exergame. EF= Executive Functions PA = Physical Activity. DDR = Dance Dance Revolution CC= Cognitive Engagement CG = Control Group EG = Experimental Group BMI = Body Mass Index.

The 3 chosen studies were intervention papers, its groups being chosen for convenience reasons. Only one of these studies carried out intensity measures for the exercises through the number of steps made during the activity (Gao *et al*, 2013b). To assess the cognitive measures, the following tests were used: Digit span forward and backward, Color trails test, and the Stroop task (Anderson et al, 2011); Utah criterion-referenced test (Gao et al, 2013a); Self-efficacy Likert-type Scale (Gao et al, 2013b). Only Gao *et al*, (2013b), usded co-variables (gender and age)

Anderson *et al*. (2011) carried out two pilot studies which lasted for 20 minutes. The experimental groups practiced the DDR and Cyber Cycling games, according to the study. Both groups improved the executive functions ($P < 0.001$ and $P = 0.03$) in comparison to the control groups, which had to watch a video that lasted for the same time. Gao *et al*. (2013A), after two years of study determined that the experimental group based on DDR improved in math and in the one mile race in comparison to the two control groups ($P = 0.01$). Gao *et al*. (2013b) after 9 months of intervention, demonstrated that the group based on DDR improved in auto-conception and enjoyment ($P < 0.001$; $P < 0.01$) in comparison to the group based on aerobics dance, although this group did vigorous PA for a longer time ($P < 0.01$).

Discussion and conclusions

This paper has review the current literature on DDR and its impact on the children's and teenager's cognition. Three were the included studies and all proved to have a positive influence between these variables. Just one study included co-variables. These results suggest that promoting programs through DDR could have a great potential for the cognitive and academic development in this educational stage (Coe, Peterson, Blair, Shutten y Peddie, 2013). There are empirical evidence that show how the EX, thanks to their implicit part involving PA, have a positive effect on the cognitive and academic performance (Benzing and Schmitd, 2017). Studies listed in this paper confirm the data shown in previous studies, although they do so in children, older people or people suffering from a specific condition (Adkins et al, 2013; Azevedo et al, 2014).

Regrding the cognitive performance, the executive functions are the most affected part. Best (2012), after four hours of intervention which was based on Nintendo Wii, demonstrated that young people who practiced with this EX modality improved their executive functions in comparison to the group that developed sedentary activities. As a matter of fact, the EX offer the opportunity to interact with other participants, since the collective practice is very common. Such action may exert benefitial effects, for it allows to meet new classmates, strengthen friendships or the self-esteem, the personal mood or to motivate towards accomplishing new challenges. Lieberman (2006) in a study that was developed with the DDR video game proved that teenagers stated that entertainment was the main reason to play, followed by the social interaction, and meeting other players. Other studies have focused on the adult population, such as Anderson-Hanley *et al*. (2012), evidencing an improvement in the executive functions corresponding to the experimental group in comparison to the control group. The first group trained with an cycle ergometer in a virtual environment while the other did the same activity but not in a virtual environment. These results are in accordance with those that were found by Keogh *et al*, (2014), who conducted a research on the effects of Nintendo Wii Sport on adults, with the conclusion that

the EX can improve the cognitive functions by improving some aspects associated with the quality of life. More recently, Gao *et al.* (2016) observed that after 6 weeks of activities in children population with different EX like the Nintendo Wii or Xbox for 50 min, their behavior at class was improved ($p < .01$). Ruiz-Ariza *et al*. (2018) analyzed the effect of 8 weeks of the augmented reality game called Pokemon GO on the cognitive performance and the emotional intelligence of teenagers. Teenagers between 12 ans 15 years old who played Pokemon GO increased their selective attention ($p = 0.003$), concentration ($p > 0.001$) and sociability ($p = .003$) in comparison to the classmates who did not play this EX. In this case, Pokemon GO combines the real and ficitious world into only one interface, substituting the static game for the active game, forcing its players to explore their physical world and to connect with peers (Serino, Cordrey, McLaughlin, and Milanaik, 2016). Some recent studies have proved that augmented reality could also enhance other characteristics belonging to the educational development like the quality of writing (Wang, 2017), math skills (Sommerauer & Müller, 2014) or learning a foreign language in the case of young people (Hsu, 2017).

In addition to the aforementioned benefits, the doing systemaic PA through EX helps to improve other variables like the self-esteem, social behavior, auto-efficiency, and motor skills (Flynn *et al*, 2015, Ruiz-Ariza *et al*, 2018) regardless of the chosen EX's modality. As we have been able to observe, the EX have enough potential as to provide direct benefits for the user, derived from the PA's practice, allowing to transform the sedentary time into an active one, improving the cognitive capacity and, lastly, fostering a more active and healthy lifestyle. In order to explain the causality relationship between the EX and cognition, this might be due to the own physiological adaptations produced by the Pa's practice, increasing the blood flow that reaches the cerebral cortex, favoring the synaptic connections and the information's processing speed (Ardoy *et al*, 2014; Hillman, Erickson y Kramer, 2008). All these changes present a positive effect on the AP for they improve behavior, attention and learning ability (Chaddock *et al*, 2014; Ruiz-Ariza *et al*, 2017). In addition, other studies have proved how the increase in the musculo-skeletal capacity, the aerobic capacity or the amount of PA that has been practiced, for example through the EX DDR would have a positive relationship with a highest cognitive competence at these ages (Chaddock *et al*, 2014).

Educational Implications

Current society demands a continuous updating regarding new educational methods adapted to the requirements of the 21st century's young population. With the aim of achieving significant and functional learning and to search for alternatives that can be really useful in response to the current educational needs. In the present case, and before the growing use of the new technologies, they can be actually useful to invigorate the teaching-learning process in a motivating way.

Nowadays, an increasing number of scientific-educational initiatives are including the EX in the school's dynamics, mainly in the Physical Education classes. As well, it is becoming more frequent for this kind of activities to be offered during the playground or at the end of the school day as complementary activities, since the offered benefits are attractive to the educational community. For example, one of the experiences that was carried out with the EX in the educational centers implied two high schools from England for approximately 12 months, with the objective of enhancing and offering new opportunities to do PA. For that purpose, dance pads were included in the Physical Education classes and they were available at breaks, lunch time and during out-of-school time. The results found showed that after practicing EX, quality of life, autonomy and the relationship with their parents improved (Azevedo, Watson, Haighton and Adams, 2014).

As for Lindberg, Seo and Teemu (2016) they developed an app for Smartphones that allowed primary school students to compete in "pedagogical missions", which requested players to have a tactical thinking and to exercise in order to resolve the posed challenges. In this study, 61 students participated, 32 of which learned the syllabus by making use of the app and 29 did so the traditional way. The results showed that the group that used EX had a more efficient learning, was more engaged and their heart rate increased in comparison to the group that was learning the traditional way.

Another experience that was carried out by Sun (2012) consisted of the integration of different EX in the Physical Education classes for a whole year. The used EX were combat simulators, DDR or a boxing simulator, among others. The participants were 74 in total, aged between 9 and 12, divided into four class groups. At the Physical Education class, each student could freely choose which EX to play. In the event of being 18 students or more at that time at class, they would play DDR, since more people can play it. The results found that an increase in the PA's intensity and health benefits for those who played.

Ruiz-Ariza *et al*. (2018) analyzed the effect of two months playing Pokemon GO on the cognitive performance and the emotional intelligence of teenagers. The Pokemon GO players enhanced their selective attention, concentration and sociability levels in comparison to their classmates.

In view of the interventions and other studies that have been displayed all along this paper, there is an increasing need for innovating in such a a way that teaching and practicing PA is more appealing. These two variables can complement each other, allowing to include syllabus content into both elements. In accordance with the shown studies, the ideal way to include this kind of technologies into the educational centers would be as a complementary material for the Physical Education lessons, constituting an alternative for the different lessons that are to be taught during the academic year. Another interesting form of including this EX modality would be to do so by making use of the Project-Based Learning, Gamification or Augmented Reality, which would allow for it to be addressed from any area. Finally, including DDR in the class breaks could promote the school performance during the posterior hours.

Conclusion

The inclusion of DDR or active video games is very much appealing for the users and it is also a good way to increase the current PA levels, with all the healthy benefits that doing so entails. In addition to that, including them allows to improve the cognitive activity, which has a positive impact in the students' academic and social performance. Their inclusion in the educational centers through new active methodological models also means a big revolution, since it enables us to transform the classroom or the lesson inside new spaces that are more original and that can better motivate in order to learn the key competencies, consequently allowing for them to be more integrally developed and also enabling students to learn in a more real way, which favors a correct intellectual, motor, personal and social development.

Bibliographic References

Åberg, M. A., Pedersen, N. L., Torén, K., Svartengren, M., Bäckstrand, B., Johnsson, T., & Kuhn, H. G. (2009). Cardiovascular fitness is associated with cognition in young adulthood. *Proceedings of the National Academy of Sciences*, *106*(49), 20906-20911.

Adkins, D. L., Boychuk, J., Remple, M. S., & Kleim, J. A. (2006). Motor training induces experience-specific patterns of plasticity across motor cortex and spinal cord. *Journal of applied physiology*, *101*(6), 1776-1782.

Anderson-Hanley, C., Tureck, K., & Schneiderman, R. L. (2011). Autism and exergaming: effects on repetitive behaviors and cognition. *Psychology research and behavior management*, *4*, 129.

Anderson, N., Steele, J., O'Neill, L. A., & Harden, L. A. (2016). Pokemon go: Mobile app user guides. *British Journal of Sports Medicine*. doi: 10.1136/bjsports-2016-096762

Ardoy, D. N., Fernández-Rodríguez, J. M., Jiménez-Pavón, D., Castillo, R., Ruiz, J. R., & Ortega, F. B. (2014). A physical education trial improves adolescents' cognitive performance and academic achievement: the EDUFIT study. *Scandinavian Journal of Medicine & Science in Sports*, *24*(1), e52-61. doi: 10.1111/sms.12093

Azevedo, L. B., Watson, D. B., Haighton, C., & Adams, J. (2014). The effect of dance mat exergaming systems on physical activity and health–related outcomes in secondary schools: results from a natural experiment. *BMC public health*, *14*(1), 951. doi: 10.1186/1471-2458-14-951

Baranowski, T. (2017). Exergaming: Hope for future physical activity? Or blight on mankind? *Journal of Sport and Health Science*, *6*(1), 44-46. doi: 10.1016/j.jshs.2016.11.006

Barnett, A., Cerin, E., & Baranowski, T. (2011). Active video games for youth: a systematic review. *Journal of Physical Activity and Health*, *8*(5), 724-737. doi: 10.1123/jpah.8.5.724

Baskin, M. L., Thind, H., Affuso, O., Gary, L. C., LaGory, M., & Hwang, S. S. (2013). Predictors of moderate-to-vigorous physical activity (MVPA) in African American young adolescents. *Annals of Behavioral Medicine*, *45*(1), 142-150. doi: 10.1007/s12160-012-9437-7

Best, J. R. (2012). Exergaming immediately enhances children's executive function. Developmental Psychology, 48(5), 1501e1510. doi: 10.1037/a0026648

Cadenas-Sanchez, C., Vanhelst, J., Ruiz, J. R., Castillo-Gualda, R., Libuda, L., Labayen, I., Ortega, F. B. (2016). Fitness and fatness in relation with attention capacity in European adolescents: The HELENA study. *Journal of Science and Medicine in Sport*. doi: 10.1016/j.jsams.2016.08.003

Cassilhas, R. C., Viana, V. A., Grassmann, V., Santos, R. T., Santos, R. F., Tufik, S. E. R. G. I. O., & Mello, M. T. (2007). The impact of resistance exercise on the cognitive function of the elderly. *Medicine and science in sports and exercise*, *39*(8), 1401. doi: 10.1249/mss.0b013e318060111f

Castelli, D. M., Hillman, C. H., Buck, S. M., & Erwin, H. E. (2007). Physical fitness and academic achievement in third-and fifth-grade students. *Journal of Sport and Exercise Psychology*, *29*(2), 239-252. doi: 10.1123/jsep.29.2.239

Chaddock-Heyman, L., Erickson, K. I., Holtrop, J. L., Voss, M. W., Pontifex, M. B., Raine, L. B., & Kramer, A. F. (2014). Aerobic fitness is associated with greater white matter integrity in children. *Frontiers in human neuroscience*, *8*, 584. doi: 10.3389/fnhum.2014.00584

Chaddock L, Hillman CH, Pontifex MB, Johnson CR, Raine LB, Kramer AF. (2012) Childhood aerobic fitness predicts cognitive performance one year later. *Journal of Sports Sciences,* 2012; 30:421-430. doi: 10.1080/02640414.2011.647706

Chao, Y. Y., Scherer, Y. K., & Montgomery, C. A. (2015). Effects of using Nintendo Wii™ exergames in older adults: a review of the literature. *Journal of aging and health*, *27*(3), 379-402. doi: 10.1177/0898264314551171

Coe, D. P., Peterson, T., Blair, C., Schutten, M. C., & Peddie, H. (2013). Physical fitness, academic achievement, and socioeconomic status in school-aged youth. *Journal of School Health*, *83*(7), 500-507. doi: 10.1111/josh.12058

Diamond, A. (2013). Executive functions. *Annual Review of Psychology*, *64*, 135–68. doi: 10.1146/annurev-psych-113011-143750

Esteban-Cornejo, I., Tejero-Gonzalez, C. M., Sallis, J. F., & Veiga, O. L. (2015). Physical activity and cognition in adolescents: A systematic review. *Journal of Science and Medicine in Sport / Sports Medicine Australia*, *18*(5), 534–9. doi: 10.1016/j.jsams.2014.07.007

Esteban-Cornejo, I., Tejero-González, C. M., Martinez-Gomez, D., Del-Campo, J., González-Galo, A., Padilla-Moledo, C., & UP & DOWN study group. (2014). Independent and combined influence of the components of physical fitness on academic performance in youth. *The journal of pediatrics*, *165*(2), 306-312.

Fung, V., Ho, A., Shaffer, J., Chung, E., & Gomez, M. (2012). Use of Nintendo Wii Fit™ in the rehabilitation of outpatients following total knee replacement: a preliminary randomised controlled trial. *Physiotherapy*, *98*(3), 183-188.

Gao, Z., Hannan, P., Xiang, P., Stodden, D. F., & Valdez, V. E. (2013). Video game–based exercise, Latino Children's physical health, and academic achievement. *American journal of preventive medicine*, *44*(3), S240-S246.

Gao, Z., Zhang, T., & Stodden, D. (2013). Children's physical activity levels and psychological correlates in interactive dance versus aerobic dance. *Journal of Sport and Health Science*, *2*(3), 146-151.

Gao, Z., Chen, S., Pasco, D., & Pope, Z. (2015). A meta-analysis of active video games on health outcomes among children and adolescents. *Obesity reviews*, *16*(9), 783-794.

Gutiérrez, M., & López, E. (2012). Motivación, comportamiento de los alumnos y rendimiento académico. *Infancia y aprendizaje*, *35*(1), 61-72.

Haapala, E., Poikkeus, A., Kukkonen-Harjula, K., Tompuri, T., Lintu, N., Väistö, J. Lakka, T. (2014). Associations of Physical Activity and Sedentary Behavior with Academic Skills – A Follow-Up Study among Primary School Children. *PLOS ONE*, *9*(9) doi: 10.1371/journal.pone.0107031

Haapala, E. A. (2013). Cardiorespiratory fitness and motor skills in relation to cognition and academic performance in children–a review. *Journal of human kinetics*, *36*(1), 55-68.

Hillman, C. H., Buck, S. M., Themanson, J. R., Pontifex, M. B., & Castelli, D. M. (2009). Aerobic fitness and cognitive development: Event-related brain potential and task performance indices of executive control in preadolescent children. *Developmental psychology*, *45*(1), 114.

Hogan, C. L., Catalino, L. I., Mata, J., & Fredrickson, B. L. (2015). Beyond emotional benefits: Physical activity and sedentary behaviour affect psychosocial resources

through emotions. *Psychology & Health*, *30*(3), 354–369. doi: 10.1080/08870446.2014.973410

Hsu, T.-C. (2017). Learning english with augmented Reality: Do learning styles matter? *Computers & Education*, 106, 137e149. doi: 10.1016/j. compedu.2016.12.007

Joronen, K., Aikasalo, A., & Suvitie, A. (2016). Nonphysical effects of exergames on child and adolescent well-being: a comprehensive systematic review. *Scandinavian Journal of Caring Sciences*. doi: 10.1111/scs.12393

LeBlanc, A. G., & Chaput, J. P. (2016). Pokémon Go: A game changer for the physical inactivity crisis? *Preventive Medicine*. doi: 10.1016/j.ypmed.2016.11.012

Lieberman, D. A. (2006). What can we learn from playing interactive games. *Playing video games: Motives, responses, and consequences*, 379-397.

Martínez-Gómez, D., Ruiz, J. R., Gómez-Martínez, S., Chillón, P., Rey-López, J. P., Díaz, L. E., & Marcos, A. (2011). Active commuting to school and cognitive performance in adolescents: the AVENA study. *Archives of pediatrics & adolescent medicine*, *165*(4), 300-305.

Niebla J, Hernández-Guzmán L. (2007). Variables que inciden en el rendimiento académico de adolescentes mexicanos. *Revista Latinoamericana de Psicología*, 39 (3):487-501.

Nigg, C. R., Mateo, D. J., & An, J. (2016). Pokémon GO May Increase Physical Activity and Decrease Sedentary Behaviors. *American Journal of Public Health*, e1–e2. doi: 10.2105/AJPH.2016.303532

Norris, E., Hamer, M., & Stamatakis, E. (2016). Active Video Games in Schools and Effects on Physical Activity and Health: A Systematic Review. *The Journal of Pediatrics*. doi: 10.1016/j.jpeds.2016.02.001

Nurkkala, V. M., Kalermo, J., & Jarvilehto, T. (2014). Development of exergaming simulator for gym training, exercise testing and rehabilitation. *Journal of Communication and Computer*, *11*, 403-411.

Ortega, F. B., Ruiz, J. R., Castillo, M. J., & Sjöström, M. (2008). Physical fitness in childhood and adolescence: a powerful marker of health. *International journal of obesity*, *32*(1), 1-11.

Roemmich, J. N., Lambiase, M. J., McCarthy, T. F., Feda, D. M., & Kozlowski, K. F. (2012). Autonomy supportive environments and mastery as basic factors to motivate physical activity in children: a controlled laboratory study. *International Journal of Behavioral Nutrition and Physical Activity*, *9*(1), 16.

Ruiz-Ariza, A., Grao-Cruces, A., Loureiro, N. E. M., & Martínez-López, E. J. (2017a). Influence of physical fitness on cognitive and academic performance in adolescents: A systematic review from 2005–2015. *International Review of Sport and Exercise Psychology*, *10*(1), 108–133. doi: 10.1080/1750984X.2016.1184699

Ruiz-Ariza, A., de la Torre-Cruz, M. J., Suárez-Manzano, S., & Martínez-López, E. J. (2016). Active commuting to school influences on academic performance of Spanish adolescent girls. *Retos*, *32*, 39–43.

Ruiz-Ariza, A., Ruiz, J., De la Torre-Cruz, M., Latorre-Román, P., & Martínez-López, E. J. (2016). Influence of level of attraction to physical activity on academic performance of adolescents. *Revista Latinoamericana de Psicología*, *48*(1), 42–50. doi: 10.1016/j.rlp.2015.09.005

Ruiz-Ariza, A., Casuso, R. A., Suarez-Manzano, S., & Martínez-López, E. J. (2018). Effect of augmented reality game Pokémon GO on cognitive performance and emotional intelligence in adolescent young. *Computers & Education*. 116, 49-63 doi: 10.1016/j.compedu.2017.09.002

Ruiz, J. R., Ortega, F. B., Castillo, R., Martín-Matillas, M., Kwak, L., Vicente-Rodríguez, G., & Moreno, L. A. (2010). Physical activity, fitness, weight status, and cognitive performance in adolescents. *The Journal of Pediatrics*, *157*(6), 917-922–5. doi: 10.1016/j.jpeds.2010.06.026

Sergeant, J. A. (2005). Modeling attention-deficit/hyperactivity disorder: a critical appraisal of the cognitive-energetic model. *Biological psychiatry*, *57*(11), 1248-1255.

Serino, M., Cordrey, K., McLaughlin, L., & Milanaik, R. L. (2016). Pokemon go and augmented virtual reality games: A cautionary commentary for parents and pediatricians. *Current Opinion in Pediatrics*, 28(5), 673e677. doi: 10.1097/MOP.0000000000000409

Sommerauer, P., & Müller, O. (2014). Augmented reality in informal learning environments: A field experiment in a mathematics exhibition. *Computers & Education*, 79, 59e68. doi: 10.1016/j.compedu.2014.07.013

Smits-Engelsman, B. C., Jelsma, L. D., & Ferguson, G. D. (2016). The effect of exergames on functional strength, anaerobic fitness, balance and agility in children with and without motor coordination difficulties living in low-income communities. *Human movement science*, 55, 327-337. doi: 10.1016/j.humov.2016.07.006

Staiano, A. E., & Calvert, S. L. (2011). Exergames for Physical Education Courses: Physical, Social, and Cognitive Benefits. *Child Development Perspectives*, *5*(2), 93–98. doi: 10.1111/j.1750-8606.2011.00162.x

Stanmore, E., Stubbs, B., Vancampfort, D., de Bruin, E. D., & Firth, J. (2017). The effect of active video games on cognitive functioning in clinical and non-clinical populations: a meta-analysis of randomized controlled trials. *Neuroscience & Biobehavioral Reviews*, 78, 34-43. doi: 10.1016/j.neubiorev.2017.04.011

Stodden, D. F., Goodway, J. D., Langendorfer, S. J., Roberton, M. A., Rudisill, M. E., Garcia, C., & Garcia, L. E. (2008). A developmental perspective on the role of motor skill competence in physical activity: An emergent relationship. *Quest*, *60*(2), 290-306.

Wrann CD, White JP, Salogiannnis J, et al. Exercise induces hippocampal BDNF through a PGC-1α/FNDC5 pathway. *Cell Metabolism*, 2013;18(5):649-659. doi: 10.1016/j.cmet.2013.09.008

Zeng, N., Pope, Z., Lee, J. E., & Gao, Z. (2016). A systematic review of active video games on rehabilitative outcomes among older patients. *Journal of Sport and Health Science*, 6(1), 33-43. doi: 10.1016/j.jshs.2016.12.002

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