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Do Board Games Make People Smarter?
Two Initial Exploratory Studies

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ABSTRACT

In recent years, the authors have witnessed the rebirth of board games. This contribution aims to investigate the educational potential of non-random board games in two ways: the comparison of performances of "expert adult players" and "adult non-players" through a correlation study (n=45) and the comparison between the results achieved by a group of children after 26 hours of game training (n=10) and those of a control group that carried out traditional educational activities (n=10) by using a nonrandomized control group pretest-posttest. Specifically, the findings relating to fluid intelligence, analytical and converging cognitive processes and creativity were compared. The results suggest that non-random board games can be an important stimulus for the cognitive functions, with a particular focus on the creative side, and therefore have an important educational function.

KEYWORDS

Board Games, Cognition, Experimental Research, Intelligence, Learning

INTRODUCTION

In "The play of animals" Gross (1898) described some interesting animal behaviours. The wild peacocks, for every day. In turn, two of them at a time enter the circle and a real battle begins. If one of them leaves the circle, the fight stops. This bizarre behaviour, just like so many others described by Gross, can be traced back to just one thing: the game. Like the animals, we also play, and in fact we are "Homo-Ludens" (Huizinga, 1967). The poet Friedrich Schiller said that man is entirely man only when he plays. Lorenz "believed" that "both art and the yearning of man for knowledge are nothing more than outward signs of the great game in which nothing is predefined, except for the rules of the game itself." (Lorenz, 1983, p. 64). Game is innate in our nature, curiosity is game, knowledge and art are game. In this contribution game is framed as a tool through which different situations can be "simulated" or "experienced," so that learning can be structured and lead to the educational success.

Why is Studying Games Necessary, Nowadays?

David Sudnow, a pianist, realised in 1983 that he was addicted to one of the very first domestic games: Breakout. He narrates his story in a book and describes the game as "Thirty seconds of play, for three bricks, and I'm on a whole new plane of being, all synapses wailing" (Sudnow, 1983, p. 41). Sudnow felt completely focused, to the limits of his capabilities, and he experienced the *Flow*, "the satisfying and exciting feeling of creative accomplishment and increased functioning. (Csikszentmihàlyi, 1975, p. XIII). The experience of Flow was first theorized by Csìkszentmihàlyi in 1975; he stated that "games

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are an obvious source of flow, playing is the experience of flow *par excellence*" (Csikszentmihàlyi, 1975, p. 37). Players experience more than anyone else this state of mind that motivates them and makes them *Fieri (Proud)* of their work.

Fiero is also the Italian word adopted by game designers from all over the world, introduced by Nicole Lazzaro at the Game Developers Conference. In fact, there is no word in English to describe the moment when "we throw our arms up and scream." (McGonigal, 2011, p. 34). Proudness is one of the most powerful neurochemical peaks we can experience (Hoeft, Watson, Kesler, Bettinger, & Reiss, 2008). That is why communities of players arise spontaneously: blogs, wikis, forums and YouTube channels. The truth is that "Reality doesn't motivate us as effectively. Reality is not designed to maximize our potential." (McGonigal, 2011, p. 3). We could say the same thing for educational paths, it seems that they are not designed to maximize students' learning. There is a direct, real and concrete feedback in the game. It is difficult to link the action to its feedback when it is distant in time, whereas the closer the feedback is to the action, the more effective it is. In a game, continuous feedback is provided allowing to change strategies of action, similarly in learning immediate feedback should be encouraged in order to change behaviour. For example, mistakes during a path could be considered as feedback. Even a mistake in games is considered an integral part of the learning process, generating permanent optimism and promoting inductive reasoning (Metcalfe, 2017). On the contrary, in learning pathways the error is often seen in a negative way and causes the motivation to be lowered to the point of constituting a real "block." A Finnish research team (Ravaja, Saari, Salminen, Laarni, & Kallinen, 2006) found that the emotional peak in games does not occur when you exceed a level but when you fail. The game under consideration in this case is Monkey Ball 2. In short, if the error is rewarded, even in a small part, the player is motivated (in the case of Monkey Ball 2, the reward for failure was a sneering monkey that fell into the void). The feedback mechanism in the games perfectly reflects Vygotsky's (1978) theory of the "proximal development zone." The player, in fact, through small tasks, is accompanied (but not too much) in finding the solution and then is rewarded. In a playful environment, moreover, tasks are perfectly balanced for their own game level, they are never too difficult or too easy. Another important factor is cooperation. In games, there is always someone to help you accomplish your mission. The success of Word of Warcraft is mainly due to this: it was the first game to introduce mechanisms that generate trust between players (they even invented an economic system for sharing rewards within teams). In learning, these processes are handled differently: being "accompanied" is considered a sign of a specific difficulty of the student; being calibrated to the group (or, worse, to "programs"), the level does not take into account individual resources and limitations; cooperation is often discouraged and most tasks are individual.

GAMES AND EDUCATION

Why board games? Literature concerning the board games is unfortunately very poor. It is abundant if we include chess in the term "board games." Gobet and Campitelli in Educational benefits of chess instruction: A Critical Review (2006) highlight an important and problematic detail of chess education: "While chess education is beneficial at the beginning, this benefit decreases as chess skills grow" (Gobet & Campitelli, 2006, p. 25). This happens because in chess the properties of space are learned quickly and at that point the learning promoted by the game is saturated. The truth after all, as Koster says, is that "The fun of games comes from apprenticeship. It comes from understanding... When playing, learning is drugs" (2004, p. 8-9).

Cook defines game mechanics as "rule-based systems\simulations that facilitate and encourage the user to explore and learn the properties of the space of possibility through the use of feedback mechanisms" (2006). The latter definition perfectly explains the relationship between mechanics and feedback, focusing on the concept of learning. Modern board games allow to explore a very vast and complex world, where the strategies undertaken are different in each game. In a game table it is not uncommon to see the "Analysis Paralysis," a phenomenon that afflicts players who are too strategic,

who abruptly slow down the game by calculating costs and benefits of every single move. This is because many modern games require a high cognitive load, caused by two components: complexity and complication. Complexity refers to the number of choices to be considered at each turn and the set of long-term consequences that such choices imply. An example is Dominant Species (Jensen, 2010), a game of majorities, where in each turn you have a wide range of options that must be calculated for 3/5 hours. Another example is "Go" where two rules imply extreme complexity and freedom of play; the possible moves in this game in fact are $2{,}08 \times 10^{170}$. A Korean proverb says that no Go game has been played twice. The complicacy refers instead to the abundance of rules with consequent subrules, special cases and exceptions. An example in this case is represented by Arkham Horror (Launius & Wilson, 2005) a very simple game in the mechanics but with an extremely long regulation of about 60 pages, including FAQ. If we wanted to create a classification we could divide the games into 4 macro-categories: 1. Children games, that are games for children; 2. Family games, developed for families and casual players; 3. Gateways, translated into "passing," with medium difficulty; 4. Hardcore games, hard games, for experienced players. Modern games are creative, every year hundreds of new more and more interesting games are launched; the game mechanics, hitherto considered as fundamental, are overturned; board games are constantly evolving. Take for example The Mind (Warsch, 2018), a 4-player cooperative family game, which is described in the boardgamegeek.com forum as follows "The Mind is more than just a game. It's an experiment, a journey, a team experience in which you can't exchange information, yet will become one to defeat all the levels of the game." In The Mind (Warsch, 2018) there is a deck with cards numbered from 1 to 100, each player receives a hand composed of as many cards as the level (Level 1, 1 card to each player, level 2, 2 cards to each player, etc..) and the purpose is to play the cards in ascending order, in turn, without being able to communicate in any way. There are almost 100,000 games in the boardgamegeek.com database (the largest site specialized in board games) where we can find games for every type of user. A recent research (Willet, Moudgalya, Boltz, Greenhalgh, & Koehler, 2018) has analyzed more than 7 million reviews of board games in the boardgamegeek.com forum and only 1,978 (0.1%) contained the word "education." This reflects an underestimation by players of the educational value of board games. Neither Monopoly nor Risiko will be discussed here. The problem with this type of titles is the very high random component. In Monopoly every turn has a completely random outcome: I throw the dice, I arrive in the Boardwalk, I lose everything! This way, the game loses that sense of intellectual challenge that most players are looking for. Modern games do not eliminate randomness, on the contrary they turn it into an important strategic detail, namely probability. For instance, in Dice Forge (Bonnessée, 2017), the dices can be modified, the faces can be removed and replaced, the player must create his/her own dice progressively enhancing it according to the rules of the game, a real dice building mechanics. Board games allow a three-dimensional contact with the pieces: touching the pieces, moving them and having a contact with real components, according to Heyden et al. (2017), is essential for children aged 8 to 12 years, because it helps them to put into practice their spatial and object rotation skills. In recent years, many board games have been digitized. It was an economically inevitable process, which profoundly changes the gameplay. Rogerson et al. (2015) have carried out an interesting research project, analyzing problems and criticalities of the real and digital versions of board games. In short, what emerges is a drastic change in strategies caused by the absence of face-to-face playing. As an example, the tracks, the classic scoreboards, give a visual perception of the position in the game compared to other players, in digital version the tracks disappear because they take up too much space on the screen and are transformed into a mere number that undergoes increases; the perception changes completely, eliminating the comparative component. In any case, many games without real contact would not even exist. The analogue and digital game modes are very different and nevertheless adaptable. There are projects that try to combine the advantages of a real gaming environment within a virtual gaming environment, as in "Mansions of Madness" where a dashboard with thumbnails is flanked by a digital narrative environment. Games have the ability to create environments that encourage teamwork. In the last few

years, the collaborative games sector has been very successful. In schools some didactic tools have been introduced, such as the authentic tasks based on similar dynamics encouraging, and sometimes forcing, cooperation. A popular collaborative game is Pandemic, a strategic cooperative family game for 2-4 players. In Pandemic we play as diseas-fighters and the aim of the game is to collaborate in order to defeat 4 strains of diseases. The interesting thing about Pandemic is that it forces players to work together, as each player in fact has special skills that must necessarily be used to defeat the game. According to a research by Berland and Lee (2011) cooperative games such as Pandemic are a perfect environment for the development of a computational thinking.

Hypothesis

The aim of this work is to verify how much non-random board games can contribute to the development of certain learnings, both specific (disciplinary) and general (basic and transversal skills). Since this is a largely unexplored territory, we wanted to verify what skills experienced players developed compared to non-players and what effects could produce a training guided by board games. In particular, we wanted to verify if there was a contribution of games in the development of fluid intelligence, the development of analytical and converging cognitive processes and creativity.

Materials

Five tests were used in the investigation, in paper or digital form at the option of the subject. (1) The Raven's matrices PM 38 (PM38), which measure the fluid intelligence, used for both children and adults, and in particular the PM38 series D and E. The Fluid Intelligence construct, introduced by Cattell (1963), refers to the ability to adapt own thinking patterns to new problems, regardless of the acquired knowledge. Fluid intelligence is critical in a wide variety of cognitive tests and is considered to be one of the most important factors influencing learning. (Gray & Thompson, 2004) (2) The Remote Association Test (RAT) by Mednick and Mednick (1971). The test is simple: four words are presented and the subject must find the word related to those four. The items, or series of 4 words for each test were 30, presented in random order and, among them, there were 15 easy and 15 difficult items. Two forms were developed, A and B. The B form differs for 50% of the items from the A form. The first form (A) was used for the comparison group and for the pre-test in the children's group; the form B was used for the post-test. The test is generally used to measure creative potential according to Mednick's theory (1962), but it has been demonstrated (Lee, Corinne Huggins, & Therriault, 2014) that the RAT test evaluates cognitive processes similar to those of a wide range of other analytical and converging processes. (3) Alternative Uses task (AUT) by Guilford (1976) which measures the subject's ability to think in a divergent way. In this test a common object is presented, in our case it was a paper clip and the subject is asked "How many uses can you find for this object?."

In this case, we need to specify that the correction was made by counting the uses found without considering repeated answers for the final score. Such as: "Hit a tyre" and "Hit a balloon." (4) The graphic test of the creativity by Paul Torrance, and in particular the activity 3 called Lines and Circles (GRAF): in this test are presented two sheets with white figures (in our case, circles), and we asked the subjects to simply complete them in a creative way. The evaluation criteria have been specially developed and summarized in Table 1.

(5) The problem-solving inventory (PSI), kindly granted by the researchers of the University of Padova who deal with the Italian translation. In this case the test is composed of two forms, one for adults and one for children. It is divided into three scales:

1. "**Self-efficacy in own problem-solving skills**, that is the degree of confidence in own skills to cope with difficult situations. It is an index of self-confidence which can help to manage the difficulties arisen."
2. "**Tendency to deal with difficult situations**, that is the willingness to deal with or avoid difficult situations that require problem-solving skills."

Table 1. GRAF correction criteria

	0	1	2
INTERPRETATION	The image has not been interpreted	Interpretation of the proposed pattern	
DETAIL	Image without particular details	Use of two or more colours, unrefined details, fast and hasty strokes	Use of three or more colours, vivid and realistically detailed image, three-dimensionality, facial expressions and details of the usability of the objects
ORIGINALITY	Common image that appears more than twice	Image that does not appear in other tests, physical modifications of the sheet	
ACTION OR MOVEMENT	Static image without hints of movement	Image with an accentuated dynamism	
COMPLEX STRUCTURE	Examining a single circle.	Examining more circles not necessarily interpreted. 0.5 points for each interpreted circle that is part of the complex structure	

3. "**Self-control ability**, that is how much a person believes to be able to control own emotions even in the case of problematic situations."

Design

The study examines two groups, an adult group (n=45) and a group of children (n=20). The group of adults is composed of 21 experienced players and 24 non-players; in order to select the experienced players, a group of 21 players was analysed to define a time threshold allowing to identify experienced players. These 21 players are part of more associations of fans of board games, in particular it is fair to mention the most important: Hydra Games, Tana del Goblin Perugia. Thanks to their contribution the threshold was identified in five hours per week in order to divide experienced players from non-players. 54% of experienced players reported playing more than 8 hours per week. Non-players were selected paying attention in composing a group where age and level of education were the same as those of the experienced players. This procedure of group assignment has allowed to have an average age and a very similar level of education in the two groups (players and non-players), to the detriment of a randomization of the sample. The average age was 29.25 in the expert group and 27.14 in the group of non-players. The average level of education, measured as years of study, was 15.29 in the group of experts and 14.80 in the group of non-players.

In the nonrandomized control group pretest-posttest design with children, the experimental group was conventionally selected, thanks to the availability of the Perugia Science Museum for summer activities. The control group was selected within an association that carried out similar activities, paying attention to maintaining a similar average age. The experimental group consisted of 10 children with an imbalance between girls and boys, respectively 9 and 1. The control group consisted of 10 children. The average age of the control group was 12.7 years, while the average age of the experimental group was 11.2 years.

Training

The group of adults did not carry out any training. In this group, in fact, a single measurement was carried out. The analysis of children considered a nonrandomized Control Group Pretest-Posttest. The experimental group carried out a training of 26 hours by playing board games, in accordance with Trinchero's research on chess (2012), 25 hours of training is the minimum time required to observe an effect. In the meantime, the control group has carried out traditional teaching activities, by going to compulsory school normally like any other day of the week.

The 26 actual hours of training (excluding pre- and post-test) were divided into three hours a day, from Monday to Friday, over 2 weeks. In accordance with Gobet and Campitelli (2006), "compulsatoriness" undermines motivation; consequently, a plan was implemented that would allow the subjects to leave the training at any time. No child left the training. A typical morning involved children from 10 to 1:30 p.m., with appropriate breaks and well-structured activities so that no one remained without playing. The first day of training was dedicated to the explanation of the games and their rules, and in the following days children tried in turn all the games. After this phase the researchers left the children free to plan their days according to their personal preferences. The games used during the training required a separation into several groups. In the event that a group finished its game before another group, it was invited to reflect on the strategies used. After the first training days, the subjects spontaneously started to exchange opinions on the strategies. In this phase of sharing, strategic learning emerged through the comparison of the game modes used. This process also emerged in the testing phase of the experienced adults, who carried out the tests in small groups of 5/7 people. The subjects were purposely separated but despite this they tried at all costs to collaborate: in Raven's matrices, for example, they tried to work together in order to discover the variables on which to focus (such as the angles of the figures or the number of lines). Clearly, despite the pressures, any kind of exchange that could compromise the validity of the tests was limited. The mechanisms they put in place were not at all a mere copying. A similar process emerged also in the RAT test: at the end of the test the subjects who had taken the test discussed animatedly on the possible solutions to the different items. In conclusion, these behaviours are representative of the seriousness and involvement that the game has stimulated.

GAMES

The board games used during the training are 13, listed below:

Splendor (André, 2014) by Marc André, a strategic Family game for 2-4 players. In Splendor we play as merchants of Renaissance gems and the aim of the game is to buy as many as possible of development cards through gems and permanent bonuses that give a good progression of the game. This game was chosen both because it has many elements of reasoning in the short and long term and because it requires a lot of attention; the actions of other players and the continuous changes in the dashboard of the game have to be constantly monitored.

Ticket to Ride Europa (Moon, 2005) by Alan R. Moon, a Family strategic game for 2-5 players. The game has simple and elegant mechanics, it can be learned in 5 minutes and lasts about an hour. The aim in Ticket to ride is to build railway lines around continental Europe. This new edition is much more interesting than the previous ones because it requires a careful planning of the routes by the player.

The Castles of Burgundy (Feld, 2011) by Stefan Feld, a strategy game for 2-4 players lasting about 90 minutes. The game is very simple in the mechanics but hides a wide strategic complexity, which is why it is appreciated by both experienced and casual players. The aim of the game in short is to build an own feud with different types of cards each of which allows to receive more or less points depending on the combinations. Among the games used, this is one of the most complex but no particular difficulties have emerged. The range of choices for each turn is limited by a random component as each player uses two dice that depending on the result can favor certain strategies over others. The randomness is not very "felt" thanks to the modifiers that can add +1/-1 to the die roll and through some combinations it is even possible to reach a +2/-2. The choice of this game has been influenced mainly by the strategic component.

Eight-Minute empire (Laukat, 2012) by Ryan Laukat, strategic family game for 2-5 players. The game is based on two main mechanics: control of territories and collection of a set of cards; the actions of the players are mediated by the coins received at the beginning of the game. As for the duration the title is quite optimistic, usually ranging between 8 and 20 minutes. It was chosen

because usually games with territory control are very long (for example "Risiko"). Eight-Minute empire can instead drastically reduce the duration without losing the direct interaction developed by this kind of games.

Dobble (Spot it!) (Balnchot, 2009) by Denis Blanchot and Ghost Blitz (Zeimet, 2010) by Jacques Zeimet, are two party games of visual research and speed. The rules are really minimal and the skills required are exclusively manual. Games of this type are also called "fillers," that is games to fill the downtime between a heavier game and the other. Dobble, Ghost Blitz and Bellz were introduced because of the need to represent the wide range of board games on the market. Because of their ease and immediacy, they are among the most used games.

Bellz! (Reid, 2014) by Don Reid is a filler of dexterity. The aim of the game is to capture the largest number of bells with a magnetic pen. The skills required are purely manual and the duration is very short: about 10 minutes. In Bellz! It is required to work with precision, the bells in fact reach tiny size and it becomes really difficult to catch them with the magnet.

Carcassonne (Wrede, 2000) by Klaus-Jürgen Wrede, a strategic family game for 2-6 players. It is a modular map game, in which the dashboard is created by the players during the game. This mechanics, other than being the main strategy, ensures always different games. In short, each player in their turn takes a map card and attaches it to the main dashboard: the scores are calculated based on the position on the map of their "meeple." When played with a small number of players (2/3) Carcassonne offers many opportunities to develop short and long-term strategies, as the chances of catching cards useful to the own strategy increase significantly. This game was chosen because of its very interesting mechanics and, in recent years, it has become very popular among casual players.

Soqquadro (Luciani, Tucci, & Sorrentino, Soqquadro, 2014) and Soqquadro outdoor (Luciani, Tucci, & Sorrentino, Soqquadro Outdoor, 2016) by Simone Luciani, Lorenzo Tucci Sorrentino, Daniele Tascini, a party action game for 2-12 players. Soqquadro is an interesting game because it moves the real gameplay away from the table. In short, there are about 100 cards, each of which has one or more adjectives such as "green" or "soft." The aim of the players is to explore the surrounding environment looking for an object that can match the description. Soqquadro was chosen because it pushes players to find creative solutions to solve a problem in a short time within the daily environment.

Dixit (Roubira, 2008) by Jean-Luis Roubira, party game for 3-6 players. Dixit is one of the very few games that manages to stimulate empathic contact between players. In this game there is no strategy, in this game you only have to use your imagination, intuition, sense of humor and a bit of madness. Dixit consists of just 84 cards illustrated with particularly dreamlike figures and a scoreboard; and behind these minimal components, a journey hides. It was chosen for his ability to train the imagination and encourage metaphorical reasoning and creativity.

Hive (Yianni, 2001) by Jhon Yianni, an abstract 2-player game. Hive consists of twenty-two hexagonal, eleven black and eleven white pieces, each representing a variety of creatures with a unique way of moving. The aim of the game is to "block" the opponent's queen bee. In Hive the pieces cannot be eliminated or removed from the game: as a result, the gameplay is in constant tension and hides a great strategic complexity, as players have to plan, defend themselves cunningly and attack silently.

Concept (Alain & Beaujannot, 2013) by Alain Rivollet and Gaëtan Beaujannot, deduction party game for 4-12 players. In Concept there is a board with illustrations that describe a wide range of options in reality, such as: "wide," "square," "red," "music" etc. In turn, one or two players, depending on the number of participants, choose a word or a phrase and through concepts and sub-concepts must make other players guess, placing cubes, without talking. The advantage of Concept is the enormous creative freedom that is left to the players (an important factor that has led the choice): the one who knows the word can in fact use thousands of modes to get other players to the solution.

RESULTS

The analysis of the t test, as regards the comparison between experts and non-players (Figure 1), shows significant results in the Remote Association Test (RAT) test ($t = 2.884$; $p < .01$), in the Raven Matrixes (SPM 38) ($t = 4.979$; $p < .001$), in the divergent thinking test (DIV) ($t = 3.021$; $p < .01$), and in the Graphic Test (GRAF) ($t = 2.492$; $p < .05$). As far as the PSI scale 2 and 3 are concerned, the statistics are not relevant. Scale 1 of the problem-solving inventory, which refers to the "degree of confidence that a person has in own ability to cope with difficult situations" (La.r.i.o.s. - University of Padua) is significant between groups, with non-experts group higher than experimental group. ($t = -3.201$; $p < .01$).

Figure 2 shows the means of the increments in the group of children. In order to evaluate the variation in the two groups of children, we proceeded with the analysis of the baseline of the entry tests. The means were not significantly different. From the t-test analysis, a significant increase was found for the experimental group in the Remote Association test (RAT) ($t = 2.521$; $p < .05$), in the Raven matrices (SPM) ($t = 4.125$; $p < .001$), and in the divergent thinking test (DIV) ($t = 2.381$; $p < .05$).

DISCUSSION

The results of the cognitive tests (Graphic Test, Alternative Uses Task, Remote Association Test and Raven Matrices) are relevant for experienced players and for children. Experienced players score higher than non-players in the Raven matrices; similarly, children being trained score significantly higher than their control group. The Raven matrices have already been used (Unterrainer, Kaller, & Halsband, 2006), and there are no substantial differences between experienced chess players and non-players. Hänggi et al. (2014), studied chess grandmasters through an in-depth analysis from which an interesting fact emerges: Raven matrices do not produce significant results compared to those of the control group. The sample used is very similar to our own in terms of age, education and amplitude and in our analysis the Raven matrices showed an excellent level of significance.

Figure 1. Results of the group of children, Effect size (Means of the increments, difference between post-test and pre-test), bars denote the standard error

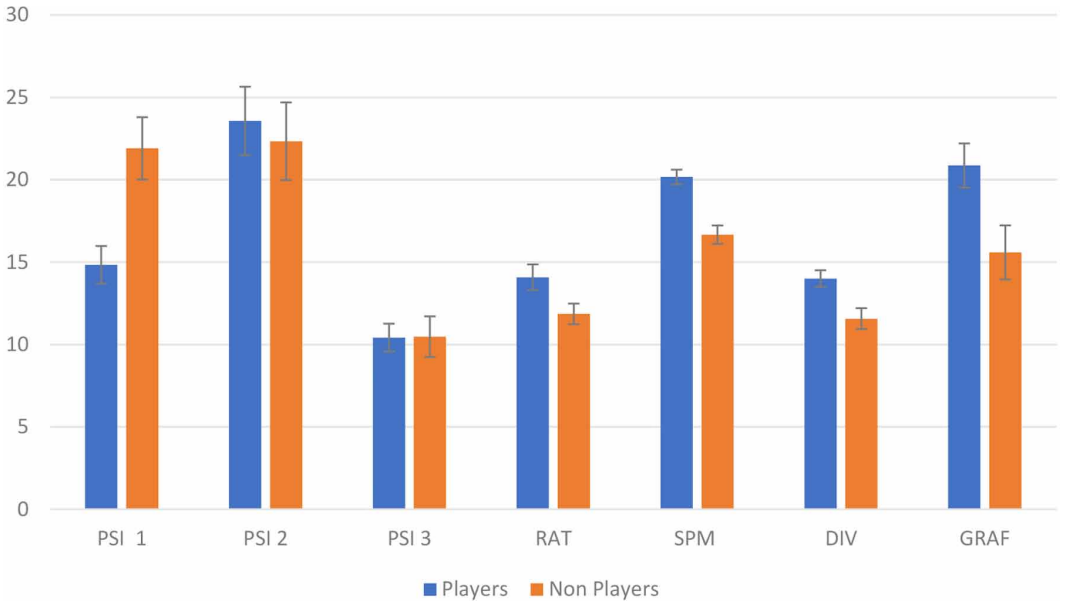
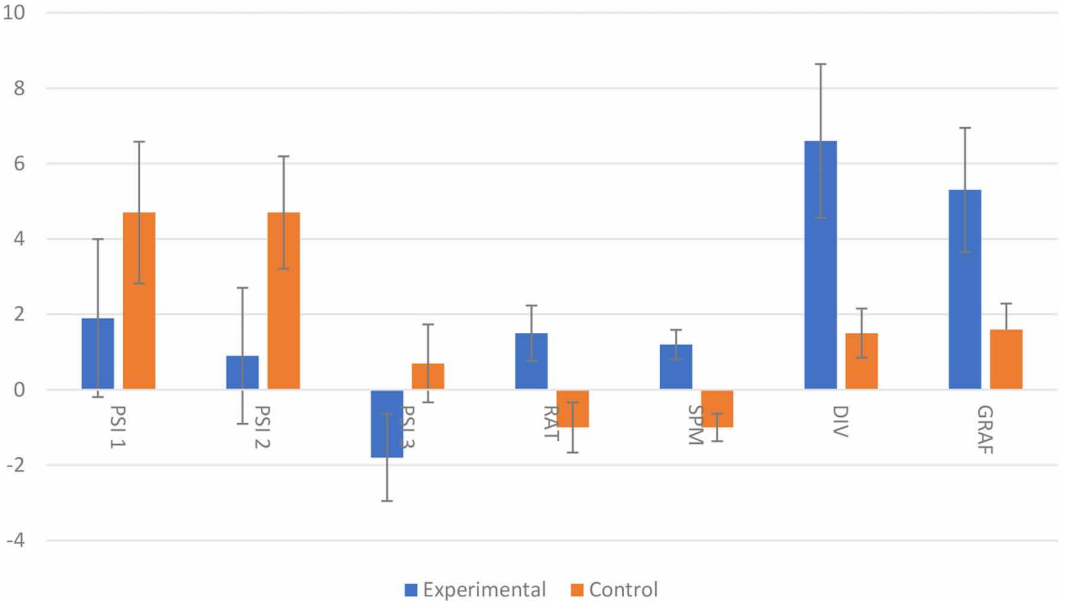


Figure 2. Results of the group of adults (Means of the raw scores), bars denote the standard error



The chess masters in fact use a reasoning based on patterns and therefore a different type from the construct measured by the Raven matrices (Gobet, De Voogt, & Retschitzki, 2004). In the Remote Association Test (RAT), expert scores far exceed those of non-players, even with the same average time. The RAT test scores, as expected, are in line with those of divergent thinking and creativity, demonstrating excellent semantic problem-solving skills. Experts have also successfully solved more difficult items in comparison with non-players. In the children's control group there was a drastic drop in the average time of completion of the RAT test. The average time of entry is 15.40 minutes while the average time of exit is 9.49 minutes. This results in fewer correct items. In the experimental group we did not see this effect, which indicates that the training has, in a way, helped children to focus on a complex task. Similar criticalities also emerge in the Raven matrices where it can be observed a lowering of the score between the incoming and outgoing tests of the control group. In the analysis on the adults, the scale 1 of the problem-solving inventory (self-efficacy in own problem-solving skills) is significant for the non-player group. The results of scale 2 (Tendency to deal with difficult situations) are not statistically significant but there is a slight trend in favour of the non-player group. Scale 3 (Self-control ability), like scale 2, does not show a statistically significant interaction. In the children's group we notice an increase in the output scores in scale 1 and 2 in both groups, while in scale 3 we notice a decrease in the scores in the experimental group. A possible explanation is that players test their skills, and when they play, they face important cognitive obstacles. Strategies pursued to overcome them are not always optimal. The perfect cost/benefit balance is not easy to calculate even considering the minimum risk. An explanation could be that children of the experimental group, as well as the experts, tested their skills by playing and found that often it is not so easy to solve a problem in a complex environment.

In a way, they "came back down to earth." Being in a complex environment make them re-evaluate their own skills. The comparison is therefore productive but extremely self-critical. Let's not forget that cognitive results indicate a substantial increase in skills after training. Board games, those played by adults and those used during training, could represent an activity of cognitive intervention for working memory. In Splendor, for example, it is required to constantly monitor the game table keeping in mind a lot of information: the number of gems on the table and in own space and the 16 development cards

constantly changing. In addition to this, the player must plan his own strategy and carefully control the strategies of other players, who may hinder him at any time. In a research (Campitelli, Gobet, Head, Buckley, & Parker, 2007) an activation of the frontal and parietal areas related to working memory arose during the recognition of pattern on chessboard by chess grandmasters. The same results emerged in Xiaohong et al. (2011), where the posterior precuneus showed a greater activation in board games (shogi) compared to other visual stimuli in both professional and amateur players. From these clues we could hypothesize a link between board games and working memory. In another research (Jaeggi, Buschkuehl, Jonides, & Perrig, 2008) it has been observed an improvement in the scores of fluid intelligence after a training with working memory (dual *n*-back task), and the results are confirmed by a recent meta-analysis (Au et al., 2015). If board games were a form of working memory training, we could explain the scores in Raven's matrices that measure fluid intelligence. As for the Rat test and the divergent thinking test, the results can be explained through the analysis of the games used for training. The mechanics of Concept reflects Mednick's theorization of creativity: "The formation of associative elements in new combinations that follow specific requirements to derive meaning and usefulness" (Mednick, 1962, p. 221). In this game, in fact, players have to use a set of illustrations (each of them referring to a concept) to explain a certain word or phrase. In order to be able to guess the word, players must necessarily put in place a creative process, the solution is not linear so that it is necessary to focus on the details of each word or phrase. Some evidence that emerged informally during the training activity shows the emerging of a Flow experience (Csikszentmihalyi, 1975) during the game: future research may answer this question.

CONCLUSION

The results show a positive effect of the training in the experimental group on both the cognitive and the creative side. Similar results emerge in the comparison analysis between experienced adults and non-players. The set of results gives us the opportunity to demonstrate how non-random board games can be an important stimulus for cognitive functions, even in learning. Game studies in recent years have mainly focused on the negative effects of video games. Recently, the Word Health Organization (WHO) stated that it will include in the ICD-11 the "gaming disorder," a pathology for addiction to video games. But we are going in the wrong direction, we need to have a more balanced perspective. While it is important to warn about the risks associated with addiction, it is also true that the potential of games is still largely unexplored. We need to create serious games, we need to create games that encourage discovery, knowledge and art. If these mechanisms work, and those who produce games know this, why do we not use them to involve and stimulate students in education? We need to make our world, and especially our school, more like a game to make teaching a real "epic mission," as Jane McGonigal says. It would be interesting in the future to see how much these results can be achieved with larger groups and different age groups. It would also be interesting to verify longitudinally the school results and listen to the teachers' feedback, as well as to verify specific disciplinary learning.

Limits

Future studies with a larger sample and better internal validity will clarify the processes that emerge and are driven by board games.

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