The effects of board games on creative potential

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Abstract

Creativity is a crucial 21st century skill. Thus, finding ways to improve the creative potential of adults is essential. Games are an effective learning tool, and some studies have investigated the effects of video games and role-playing games on creative potential. However, less is known about the potential benefits of board games. The aim of the present study was to compare the effects of creative and non-creative board games. The sample consisted of 55 university students. We used a within-subject repeated-measurement design. We assessed creative potential using a divergent thinking task, using fluency and originality as indicators. We controlled the potential effects of mood states and enjoyment. Results indicate a positive effect, for participants with low creative potential, for both types of games.

Keywords: creativity, creative potential, divergent thinking, board game, boardgame, game, training.

The effects of board games on creative potential

Creativity refers to the capacity to generate original and relevant ideas (Runco &

Jaeger, 2012). Creativity has gained recognition as one of the most crucial skills to possess in

the 21st century. This is the case for numerous jobs, which are not necessarily artistic or

creative at first glance, such as managers (IBM, 2010). From an economic perspective, since

the start of the 21st century, creative products account for about half of the economic growth

(Economist Technology Quarterly, 2002). Hence, it is important, even necessary, to find ways

to train and develop creativity. A meta-analysis by Scott, Leritz and Mumford (2004) showed

this is feasible. Among other things, the results showed that originality training produced the

largest effect size (Δ = .81, SE = .15). However, the studies included in this meta-analysis

focus mostly on direct education, and one might wonder whether leisure-based activities, such

as games, could also benefit creativity.

In our study, we explored the potential effects of different board games on the creative

potential of young adults. Using board games as a tool for learning is a popular method but

using them to develop creativity has not been explored, to the best of our knowledge. We

attempted to provide empirical evidence on this avenue for the development of creativity.

Games and learning

Defining games and play is not an easy task. Some languages do not separate those

two words. For instance, the sentence "I play a game" in French and German would use two

variants of the same word for play and game: "Je joue à un jeu" in French, "Ich spiele ein

Spiel" in German. In English, those two words take similar yet distinct meanings. Salen &

Zimmerman (2004) addressed this concern by conducting a comprehensive review of

definitions of those terms, which resulted in the following definitions. Play is "free movement

within a more rigid structure" (p. 304), and a game is "a system in which players engage in an

artificial conflict, defined by rules, that results in a quantifiable outcome" (p. 80). Games are then a subset of play, through their formalization of activities considered as play, which is itself an essential experiential aspect of a game. A more operational definition is offered by Kinzie & Joseph (2008): "a game is an immersive, voluntary and enjoyable activity in which a challenging goal is pursued according to agreed-upon rules" (p. 643). We use this definition as our basis in this article.

We focused our attention on board games, which need to be distinguished from role-playing games. A board game is a game with a certain number of rules that limit the possibilities, that requires a physical medium (e.g. a board, cards, dice) and that is played by two players or more (Gobet, De Voogt & Retschitzki, 2004). A role-playing game is a game where players must create and embody an imaginary character, who will move in a defined world and in a situation created and narrated by a game master (Karwowski & Soszynski, 2008). Strictly speaking, a role-playing game is not a board game, but rather a full-fledged leisure activity, involving a shared fantasy, engaging individual imagination and guided by the game rules (Hughes, 1988).

Many studies use board games as a learning tool. This is because games are effective in engaging people in learning (Bayliss, 2007). For instance, many Monopoly variants have been developed to teach information and new practices, as in nursing environments (Yoon et al., 2014) or in accounting firms (Shanklin et al., 2007). Chiarello & Castellano (2016) report six reasons explaining the effectiveness of board games as a facilitator for learning : (1) immersion facilitates concentration, (2) suspension of disbelief allows for an environment conducive to accepting novel ideas, (3) it enables participants to "learn by doing", (4) competitiveness motivates players to understand deeply the rules of the game, (5) downtimes promote reflection and discussion among players, (6) those downtimes are conducive to introducing explanations from the teacher, in a rather natural way. In this vein, Chiarello &

Castellano (2016) used successfully board games to introduce and teach complex topics as quantum physics to their students, showing the range of applications of board games as a learning tool.

Games and creativity

Creativity constitutes an important educational goal. Games being a powerful learning tool, it would seem logical to try to improve people's creativity through their use. The idea that game and play might be a driving force to developing creativity is not completely new : developmental psychology points out that play is one of the core activities of childhood, and that some of the most important changes in early childhood occur thanks to play (Verenikina, Harris & Lysaght, 2004). Yet, there are only a handful of studies addressing the link between games and creativity, for adult populations.

Regarding videogames and creativity, Jackson et al. (2012) conducted a survey, and found a significant positive correlation between divergent thinking and videogame playing, albeit on a 12-year-old children sample ($N = 491$). Moffat, Crombie and Shabalina (2017) conducted an experimental study on the effects of three types of video games (a first-person shooter, a sandbox game and a puzzle game[1]) on divergent thinking of young adults. Each participant ($N = 21$) completed a divergent thinking task, played one type of game for 30 minutes, and then completed another divergent thinking task. Their results showed a significant increase of flexibility, after playing the problem-solving and first-person shooter games. However, as their sample size was small, these initial findings require replication and extension.

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[1] The first-person shooter game was Serious Sam, where the player fights against waves of enemies in wide-open environments. The sandbox game was Minecraft, where the player can create, modify and destroy the game environment. The puzzle game was Portal 2, where the player solves puzzles by placing portal and teleporting between them.

Concerning role-playing games and creativity, Karwowski & Soszynski (2008) created the RPTC, a creativity training program based on role-playing games mechanics. They implemented those mechanics and rules in workshops lasting 8 hours in total. Their results showed a net improvement of creativity after the program, demonstrating its effectiveness, notably in terms of fluency. Dyson et al. (2016) replicated this program with a Taiwanese sample, and obtained similar results, adding evidence to the effectiveness of using role-playing game mechanics as a creativity learning tool. Chung (2013) conducted a survey of the creativity in three groups: tabletop role-playing games players, online role-playing games players and non-players. Overall, tabletop role-playing gamers were more creative than non-players, online role-playing game players being situated between these two groups. The effects of role-playing games on creativity might be explained by the fact that they are, essentially, an improvisation activity in which players act together towards the creation of a story. Even if the game master acts and dictates the narration from a manual, it is first and foremost an activity in which people imagine together an adventure (Williams, Hendricks & Winkler, 2006).

The present study

To our knowledge, there are no studies to date showing the effects of board games on adult's creativity. Even if a few different classifications of board game types exist, such as the ESAR system (Filion, 2015), there is no rigorous categorization of games that can serve as the basis of a scientific experiment. Therefore, we decided to base our selection of board games on the consensual definition of creativity; we defined two types of board games: creative and non-creative. A creative board game is a game that requires the production of novel and relevant ideas to perform well. In contrast, a non-creative board game does not require this creative generation to perform well. We decided to examine the effects of two creative board games, by comparing them to two non-creative board games, using two different types of

stimuli: cards and dice. We based our selection on multiple criteria : the games had to be

relatively unknown to the general public, have rules easy enough to be understood quickly

without being too childish, be engaging and enjoyable, playable by three or four players, and

be competition games, that could be finished under 30 minutes and divided clearly into

rounds.

For the creative board games, we used "The Big Idea" (2011), which is a game in

which each player has six cards, three "Thing" cards and three "Qualifying" cards, that must

be combined to create an invention. Each player is free to use as many cards as he or she

wants and in any order that the player sees fit, if it is possible to provide meaning for the

invention. When each player is finished, they must present their own invention to the others,

and present their arguments pertaining the value of their invention.

The second creative board game is "How I adopted a Gnu" (2014), which is a game in

which the player must invent a story, from a premise chosen randomly from 36 possibilites on

a card. The player has six colored dice on which are written logical connectors, that must be

thrown from lightest to darkest, the first one enabling the beginning of the story and the last

one its conclusion. The other players have one die with logical connectors, that can be thrown

at any moment, three times in the story ; this enables them to interrupt the other player's story

and draw the player away from his or her original narration.

Regarding the non-creative games, first we have a card game using a 52-card deck,

known in France as "Deutsch" ; players try to earn the lowest number of points at the end of a

deal. The values of the cards range from ace (1) to king (13). For the details of the rules, see

the Appendix.

The second non-creative game is "Qwixx" (2012), which is a dice game in which each

player has a scoring sheet, with 4 rows of colors (red, yellow, green and blue), in which are

written numbers from 2 to 12 in the first two, and from 12 to 2 in the last two. The goal is to

cross out a maximum of those numbers, from left to right only: the more numbers crossed out

in a row, the higher the score. The numbers that players can check are based on the value

obtained on six dice (two white dice, one red, one yellow, one green and one blue). For the

details of the rules, see the Appendix.

The aim of the present study was to explore the influence of board games on the

creative potential of young adults, using a pre-test and post-test paradigm, while controlling

for multiple variables such as enjoyment or openness to experience. Our main hypothesis was

as follows: the creative board games have a positive effect on the creative potential of the

participants, compared to non-creative board games. In other terms, there is an improvement

of creative potential only after playing a creative board game. We had also a secondary

hypothesis : the improvement of creativity will be higher for less creative participants

compared to more creative participants, in particular after playing a creative board game.

Method

Design and participants

We used a mixed design with within and between effects, meaning that all participant

played both a creative and non-creative game across two sessions, the order of which was

counterbalanced across participants, and the support (cards, dice) was as well. 55

undergraduates from a French university were enrolled, with 82% female and a mean age of

20.2 years ($SD = 3.83$). In total, there were 16 groups of participants, of three or four people

each (respectively nine and seven). 30 participants were assigned to the "card" games, and 25

to the "dice" games.

Materials

Board games. We used the following creative board games: How I adopted a Gnu (2014), involving dice; The Big Idea (2011), involving cards. We used the following non-creative board games: Qwixx (2012), involving dice; Deutsch, involving classic cards, of which the design was intentionally different from usual. We used the official edition and rules for every game. We designed standardized explanations so that each participant would have the same amount of information about the rules.

Creative potential assessment. To assess creative potential, we used the Alternative Uses Task (Guilford, 1950). Participants had to write down original and unusual ideas to the objects (presented as words). They worked on each object for two minutes. At each time, participants worked on a set of two words, one frequent then one non-frequent, drawn randomly from a list of four frequent (pencil, chair, knife, belt) and four non-frequent words (wheelbarrow, ice-cream cone, screwdriver, syringe). At the end of the two pre-tests and post-tests, participants had then worked on all eight words. The frequencies of those words were drawn from the Lexique 3.82 (New & Pallier, 2017), a French lexicon database. We based our choices on the lemma per million frequency of the database book corpus.

Control variables. As personality factors are associated with creative potential, notably Openness to Experience (e.g. Feist, 1998; Dollinger, Urban & James, 2004), we administered the French version of the Ten-Item Personality Inventory (TIPI, Storme, Tavani & Myszkowski, 2010). Participants' mood state was also measured, using two scales of the Self-Assessment Manikin (SAM, Bradley & Lang, 1994): happiness and excitement. Those two dimensions have been found to be associated with creative potential (Adaman & Blaney, 1996; Zenasni & Lubart, 2002). We administered the SAM before and after participants played the games, using pictural nine-point scales (1 = high happiness and excitement, 9 = low happiness and excitement), asking them to rate their current level on those two

dimensions. We measured enjoyment of the games using the Interest/Enjoyment scale of the Intrinsic Motivation Inventory (IMI, Ryan, Mims & Koestner, 1983; IMI, 1994). We checked how many people the participants knew in their group. We measured their acquaintance with the games they had played, on a three-point scale (1 = Never played it, 2 = Heard of it but never played, 3 = Played it before). All measures were administered on paper.

Procedure

After welcoming the group, we informed them that they were going to participate in an experiment on the link between fun and creativity, then we explained briefly the outlines of the two sessions. Before beginning, the participants signed a consent form. The procedure was similar for the two sessions. Those two sessions took place one week apart, on the same day and hour.

Participants started with the first set of divergent thinking tasks, comprised of a frequent and a non-frequent word. They were given the following be-creative instructions: "Please name uses for the given objects which are as unusual as possible. In this task it is important for you to be as creative as possible and to generate interesting uses one would not necessarily think of." This was followed by the first measure of their mood state. After that, we explained the rules of the game they were going to play, using standardized explanations. They played for 30 minutes, while the experimenter sat apart and remained available if they had any questions or forgot a rule. After these 30 minutes, we measured their mood state once again. Then, they were given a second set of divergent thinking tasks. After completing the tasks, we measured the rest of the control variables. At the end of the second session, we briefed them on the goal of the study and answered their questions.

Data analysis

We quantified divergent thinking in terms of fluency and originality.

To assess fluency, we counted the number of responses given by the participant, while excluding incomplete and non-adequate responses (i.e. redundant or meaningless responses).

To assess originality, we used snapshot scoring (Silvia et al., 2008; Silvia, Martin & Nusbaum, 2009), where judges rate the originality of the entire set of responses of a participant, instead of rating responses individually. Three judges independently rated the originality of the responses. They were all enrolled in a master's degree and all had courses on creativity. We asked the judges to rate originality using the following instructions: "You must rate the originality of the entire set of responses given by the participant, meaning the unusualness, the novelty of the ideas they gave, without regard to the relevance of those ideas". They rated originality using a seven-point scale and were instructed to follow a normal distribution (Lubart, Besançon & Barbot, 2011). As they processed responses on the original paper sheets, they could ask the experimenter if they could not read a response, as all responses had been transcribed beforehand. This procedure was the same for all eight words, the order of which was randomized and the same for all judges.

We used Cronbach's alpha to compute the inter-rater agreement. Beforehand, we verified the unidimensionality of the measure using an EFA. Bartlett's sphericity test was significant, $\chi^2(3) = 432$, $p < .001$. KMO was acceptable (KMO = 0.680). Based on Horn's parallel analysis (Horn, 1965), we found a one-factor solution explaining 58% of variance. Having confirmed the unidimensionality of our measure, we calculated Cronbach's alpha, which was satisfactory ($\alpha = .80$). Based on this result, we used the average of the three ratings to assess the originality of responses.

To examine the first hypothesis, ANOVA for repeated measures were conducted, for fluency and for originality. In each ANOVA, the factors TIME (pre-test vs. post-test), TYPE (creative game vs non-creative game) and ORDER (first session vs. second session) were considered. To test the second hypothesis, we conducted ANOVA for repeated measures for

fluency and originality, considering TIME (pre-test vs. post-test), TYPE (creative vs non-creative game) and PERFORMANCE (low vs. high pre-test score). Data analysis was conducted using Jamovi (2019).

Results

Training effects on fluency

Before testing our hypothesis regarding fluency, we calculated correlations between frequent and non-frequent word scores, to examine if using the average of the two scores was relevant. We obtained high correlations for pre-test scores ($r = .75$, $p < .001$) and post-test scores ($r = .70$, $p < .001$). On this basis, we chose to use the average of frequent and non-frequent scores for pre-test and post-test as an indicator of fluency.

Regarding the first hypothesis, the ANOVA revealed no main effect of TIME of measure, $F(1,106) = 0.16$, $p > .05$. There was no interaction between TIME and TYPE, $F(1,106) = 0.46$, $p > .05$. There was a significant interaction between TIME and ORDER, $F(1,106) = 4.61$, $p = .03$. There was no significant second-order interaction between TIME, TYPE and ORDER, $F(1,106) = 2.10$, $p > .05$. For descriptive statistics, see Table 1.

Regarding the second hypothesis, we dichotomized low vs. high fluency PERFORMANCE based on the average of fluency pre-test scores ($M = 4.94$, $SD = 2.31$). Participants below the average were categorized as having low fluency, and those above as having high fluency. As shown in Figure 2, the ANOVA revealed a significant interaction between TIME and PERFORMANCE, $F(1,106) = 7.32$, $p = .008$. Post-hoc comparisons revealed a significant improvement between pre-test and post-test scores ($M = 0.51$, $SE = 0.21$) for low-fluency participants, $t(106) = -2.39$, $p = .02$, and no difference ($M = -0.29$, $SE = 0.21$). for high-fluency participants, $t(106) = 1.42$, $p > .05$. There was no significant second-level interaction between TIME, PERFORMANCE and TYPE, $F(1,106) = 0.25$, $p > .05$.

Training effects on originality

Before testing our hypothesis regarding originality, we calculated correlations between frequent and non-frequent word scores to examine whether using the average of the two scores was relevant. We obtained high correlations for pre-test scores ($r = .70$, $p < .001$) and post-test scores ($r = .57$, $p < .001$). On this basis, we chose to use the average of frequent and non-frequent scores for pre-test and post-test as an indicator of originality.

Concerning the first hypothesis, the ANOVA revealed a significant main effect of the TIME of measure, $F(1,106) = 4.41$, $p = .04$. A post-hoc comparison revealed an improvement between pre-test and post-test ($M = 0.17$, $SE = 0.08$). As shown in Figure 1, there was no interaction between TIME and TYPE, $F(1,106) = 0.07$, $p > .05$. There was no interaction between TIME and ORDER, $F(1,106) = 0.03$, $p > .05$. There was no second-order interaction between TIME, TYPE and ORDER, $F(1,106) = 1.02$, $p > .05$. For descriptive statistics, see Table 1.

For the second hypothesis, we dichotomized low vs. high originality PERFORMANCE based on the average of originality pre-test scores ($M = 3.91$, $SD = 1.23$). Participants below the average were categorized as having low originality, and those above as having high originality. As shown in Figure 2, the ANOVA revealed a significant interaction between TIME and PERFORMANCE, $F(1,106) = 17,29$, $p < .001$. Post-hoc comparisons revealed a significant improvement between pre-test and post-test scores ($M = 0.52$, $SE = 0.11$) for low-originality participants, $t(106) = -4.67$, $p < .001$, and no difference ($M = -0.12$, $SE = 0.11$) for high-originality participants, $t(106) = 1.15$, $p > .05$. There was no significant second-level interaction between TIME, PERFORMANCE and TYPE, $F(1,106) = 0.01$, $p > .05$.

Control variables

To examine whether the games were as enjoyed as expected, we conducted a one-way ANOVA with the different games as an independent variable. There was a significant effect of games on enjoyment, $F(3,106) = 4.51$, $p = .005$. A Tukey post-hoc test revealed a significant difference between Deutsch ($M = 5.92$, $SD = 0.73$) and Qwixx ($M = 4.91$, $SD = 1.41$), $t(106) = 3.28$, $p = .008$. A second one-way ANOVA with TYPE as an independent variable showed no significant difference between creative ($M = 5.46$, $SD = 1.21$) and non-creative board games ($M = 5.46$, $SD = 1.20$), $F(1,108) = 0.0001$, $p > .05$. Most participants had neither played nor heard of the games, besides Deutsch. One individual reported having played The Big Idea before, and one individual reported having heard of How I adopted a Gnu. Six participants reported having heard of Deutsch, and six others had played it before. No participants had played or heard of Qwixx.

To explore potential effects of our control variables, we calculated correlations using the pre-post differences for fluency and originality. There were no significant correlations between any of the control variables and pre-post differences, for fluency and for originality.

Discussion

The goal of this study was to explore whether playing creative board games could improve creative potential, which was operationalized using two indicators of divergent thinking. We hypothesized that (H1) creative board games would have a positive effect on creative potential compared to non-creative board games, and that (H2) this effect would be greater for participants with below-average performance.

Regarding fluency, our first hypothesis was not confirmed. There was no significant effect of playing board games on fluency. Furthermore, there was no significant effect of the

type of game on the improvement of fluency. This would mean playing a creative board game

does not provide more benefits than a non-creative one. We investigated this further by

dichotomizing participants based on their initial performance. Our second hypothesis was

partially confirmed. There was a significant interaction between TIME and

PERFORMANCE. Low-fluency participants improved after playing a game, whereas high-

fluency participants did not. There was however no significant interaction between TIME,

TYPE and PERFORMANCE. Thus, playing a creative board game does not bring more

benefit than a non-creative board game, regardless of initial performance. It seems fluency

can be improved up to a certain point: whereas individuals with lower than average fluency

benefited from playing a board game, more fluent ones did not see any improvement. The

absence of improvement overall and for above-average participants could be due to the

duration of each divergent thinking task (two minutes per object). It might be possible that

already fluent individuals are not able to write every idea they had after playing a game. In

other words, someone giving a lot of ideas in the pre-test will have a hard time doing better,

even if playing did have an effect. In this regard, Amabile, Hadley & Kramer (2002) consider

creativity as a combinatory process that takes times, to explore concepts and play with ideas.

Rosso (2014) echoes this reasoning, positing a time limit might work against creativity by

inhibiting exploration. However, it is necessary to set up controlled conditions, which is

difficult without a time limit (Hattie, 1977). Said-Metwaly, Fernandez-Castilla, Kyndt & Van

der Noortgate (2019) provided an answer with a meta-analysis on the issue. After reviewing

12 studies and 57 effect sizes, they concluded that time limits had no significant effect on

fluency ($g = 1.02$, $p = .16$). However, this result is limited by the relatively small number of

studies included, so we prefer not to rule out this possibility. The overall lack of improvement

might also be due to the nature of the instructions: we instructed our participants to be

creative, rather than asking them to be fluent. Recent studies showed evidence that this

change of focus impacts the quality and quantity of ideas: when instructed to be creative,

people tend to generate more creative but fewer ideas (Forthmann et al., 2016; Nusbaum,

Silvia & Beaty, 2014). Overall, playing board games seems to have no significant effects on

fluency, even if below-average participants benefit from playing either a creative or non-

creative board game. However, fluency alone is not enough to assess divergent thinking.

Before analyzing the effects of our variables on originality, we checked the inter-rater

consistency of our measure using Cronbach's alpha. This coefficient posits that the measure is

unidimensional (Myszkowski & Storme, 2019). An EFA indicated that our measure was

unidimensional. Cronbach's α was equal to .80, meaning judges did rate the same construct.

We checked criterion validity using Openness to Experience. Correlations between Openness

and originality scores were positive and significant, corroborating the validity of our measure

of originality.

Our first hypothesis was partially confirmed. There was a significant improvement of

originality after playing a board game. However, contrary to our hypothesis, playing a

creative board game did not have any more effect than playing a non-creative one. As it was

the case for fluency, there was an improvement for below-average participants, but no

improvement for above-average ones. Consequently, playing a game brings more benefit for

less original individuals than those already capable in this regard. With regard to our control

variables, no links were found between them and pre-post differences in fluency and

originality. This would indicate the variation of mood states or the level of enjoyment do not

account for the variations we observed.

There are limitations with our study that need to be noted. First is the lack of a no-

game control condition. We chose the non-creative games as a control for creative games,

based on previously presented criterion, however it does not constitute a complete control

condition per se. We anticipated non-creative board games to bring no benefit to creative potential, thus using them as our baseline to evaluate the effects of creative board games. However, improvements occurred regardless of the type of game. These can be attributed to a training effect. To prevent this as much as possible, we used comparable yet different objects at every stage of measurement (Barbot, 2019), by controlling their lexical frequency (Forthmann et al., 2016). Another limitation concerns the external validity of our results. We have a limited sample in this study. Even though we used a within-subject design, this is still a modest sample size. This sample consists exclusively of students, which is hardly representative of the general population. We opted for a rather domain-general approach to measuring creative potential, but many studies support domain specificity (e.g. Baer, 2011). On this basis, future studies should examine the effects of games on more specific measures of creative potential and on more representative samples, for instance in a workplace setting.

This study provides a first step in examining the links between board games and creative potential. We unveiled a general effect of board games for below-average individuals, with regard to their divergent thinking. Playing board games could constitute an effective tool to improve one's divergent thinking capacity. This might notably constitute a quick and efficient method to boost creative output temporarily: in the workplace environment, it could be used for instance to improve the outcomes of a brainstorming session. The long-term effects of playing board games remain to be studied.

References

Adaman, J. E. & Blaney, P. H. (1996). The effects of musical mood induction on creativity. *Journal of Creative Behavior, 22*, 95-108.

Amabile, T. M., Hadley, C. N. & Kramer, S. J. (2002). Creativity under the gun. *Harvard Business Review, 80*, 52-147.

Bayliss, J. D. (2007). The effects of games in CS1-3. *Proceedings of Microsoft academic days conference on game development in computer science education, 2007*.

Baer, J. (2011). Domains of creativity. In M.A. Runco, & S.R. Pritzker (Eds*.), Encyclopedia of creativity* (pp. 404–408). San Diego: Academic Press.

Barbot, B. (2019). Measuring creativity change and development. *Psychology of Aesthetics, Creativity, and the Arts, 13*(2), 203–210.

Besemer, S. P., & O'Quin, K. (1999). Confirming the three factor creative product analyses matrix model in an American sample. *Creativity Research Journal, 12,* 287–296.

Bradley, M. M. & Lang, P. J. (1994). Measuring emotion: the self-assessment manikin and the semantic differential. *Journal of Behavorial Therapy and Experimental Psychiatry, 25*(1), 49-59.

Chiarello, F. & Castellano, M. G. (2016). Board Games and Board Game Design as Learning Tools for Complex Scientific Concepts: Some Experiences. *International Journal of Game-Based Learning, 6*(2), 1-14.

Chung, T. (2013). Table-top role-playing game and creativity. *Thinking Skills and Creativity, 8*, 56-71.

Comment j'ai adopté un gnou (2014). Longalive Games.

Dollinger, S. J., Urban, K. K. & James, T. A. (2004). Creativity and openness: further validation of two creative product measures. *Creativity Research Journal, 16*(1), 35-47.

Dyson, S. B., Chang, Y., Chen, H., Hsiung, H., Tseng, C. & Chang, J. (2016). The effect of tabletop role-playing games on the creative potential and emotional creativity of Taiwanese college students. *Thinking Skills and Creativity, 19*, 88-96.

Economist Technology Quarterly (2002). Thanksgiving for innovation. *Economist Technology Quarterly*, pp. 13-14.

Feist, G.J. (1998). A meta-analysis of personality in scientific and artistic creativity *Personality and Social Psychology Review, 2*(4) 290-309.

Filion, R. (2015). *Le Système ESAR. Pour analyser, classifier des jeux et aménager des espaces.* Saint-Leu-La-Forêt : A la Page.

Forthmann, B., Gerwig, A., Holling, H., Çelik, P., Storme, M. & Lubart, T. (2016). The be-creative effect in divergent thinking: The interplay of instruction and object frequency. *Intelligence, 57*, 25-32.

Gobet, F., De Voogt, A. & Retschitzki, J. (2004). *Moves in Mind: The Psychology of Board Games.* Hove: Psychology Press.

Guilford, J. P. (1950). Creativity. *American Psychologist, 5*(9), 444–454.

Hattie, J. A. (1977). Condition for administering creativity tests. *Psychological Bulletin, 84*, 1249-1260.

Horn, J. L. (1965). A rationale and test for the number of factors in factor analysis. *Psychometrica, 30*(2), 179–185

Hughes, J. (1988*). Therapy is fantasy: Role playing, healing and the construction of symbolic order*. Paper presented at Anthropology IV Honours, Medical Anthropology Seminar, Australian National University. Retrieved from:

http://www.rpgstudies.net/hughes/therapy_is_fantasy.html

IBM. (2010). *Capitalizing on Complexity : Insights from the Global Chief Executive Officer Study*. 76.

Intrinsic Motivation Inventory. (1994). Intrinsic Motivation Inventory (IMI). *The Intrinsic Motivation Inventory, Scale description*.

Jackson, L. A., Witt, E. A., Games, A. I., Fitzgerald, H. E., von Eye, A. & Zhao, Y. (2012). Information technology use and creativity: Findings from the Children and Technology Project. *Computers in Human Behavior, 28*(2), 370–376.

The jamovi project (2019). *jamovi* (Version 1.0) [Compture Software]. Retrieved from: https://www.jamovi.org

Karwowski, M. & Soszynski, M. (2008). How to develop creative imagination? Assumptions, aims and effectiveness of Role Play Training in Creativity (RPTC). *Thinking Skills and Creativity, 3*, 163-171.

Kim, K. H. (2008). Meta-analyses of the relationship of creative achievement to both IQ and divergent thinking scores. *Journal of Creative Behavior, 42*(2), 106-130.

Kinzie, M. B. & Joseph, D. R. D. (2008). Gender differences in game activity preferences of middle school children: implications for educational game design. *Educational Technology Research and Development, 56,* 643-663.

Lubart, T., Besançon, M. & Barbot, B. (2011). *Evaluation du Potentiel Créatif (EPoC). (Test psychologique et Manuel).* Paris : Editions Hogrefe France.

Moffat, D. C., Crombie, W. & Shabalina, O. (2017). Some Video Games Can Increase the Player's Creativity. *International Journal of Game-Based Learning, 7*(2), 35-46.

Myszkowski, N. & Storme, M. (2019). Judge Response Theory? A Call to Upgrade Our Psychometrical Account of Creativity Judgments. *Psychology of Aesthetics, Creativity, and the Arts, 13*(2), 167-175.

New, B. & Pallier, C. (2017). *Lexique 3.82.*

Nusbaum, E. C., Silvia, P.J., & Beaty, R. E. (2014). Ready, set, create: What instructing

people to "be creative" reveals about the meaning and mechanisms of divergent thinking.

Psychology of Aesthetics, Creativity, and the Arts, 8, 423–432.

Qwixx (2012). Gigamic.

Rosso, B. D. (2014). Creativity and constraints: Exploring the role of constraints in the

creative processes of research and development teams. *Organization Studies, 35,* 551-585.

Runco, M. A, & Jaeger, G. J. (2012). The standard definition of creativity. *Creativity*

Research Journal, 24(1), 92-96.

Ryan, R., Mims, V., & Koestner, R. (1983). Relation of reward and interpersonal context to

intrinsic motivation: A review and test using Cognitive Evaluation Theory. *Journal of*

Personal-ity and Social Psychology, 45, 736-750.

Said-Metwaly, S., Fernandez-Castilla, B., Kyndt, E. & Van den Noortgate, W. (2019). Testing

conditions and creative performance: Meta-analyses of the impact of time limits and

instructions. *Psychology of Aesthetics, Creativity, and the Arts, 13,* 1-24.

Salen, K., & Zimmerman, E. (2004). *Rules of play*. Cambridge, MA: MIT Press.

Scott, G., Leritz, L. E. & Mumford, M. D. (2004). The effectiveness of creativity training: A

quantitative review. *Creativity Research Journal, 16*, 361–388.

Shanklin, S. B., & Ehlen, C. R. (2007). Using the Monopoly Board Game As An Efficient

Tool In Introductory Financial Accounting Instruction. *Journal of Business Case Studies*,

3(3), 17–22.

Silvia, P. J., Winterstein, B. P., Willse, J. T., Barona, C. M., Cram, J. T., Hess, K. I. &

Richards, C. A. (2008). Exploring the reliability and validity of new subjective scoring

methods. *Psychology of Aesthetics, Creativity, and the Arts, 2*, 68-85. 28

Silvia, P. J., Martin, C., & Nusbaum, E. C. (2009). A snapshot of creativity: Evaluating a

    quick and simple method for assessing divergent thinking. *Thinking Skills and Creativity,*

    4, 79–85.

Storme, M., Tavani, J.-L. & Myszkowski, N. (2016). Psychometric properties of the French

    Ten-Item Personality Inventory (TIPI). *Journal of Individual Differences, 37*(2), 81-87.

The Big Idea (2011). Funforge.

Verenikina, I., Harris, P. & Lysaght, P. (2003). *Child's play: Computer games, theories of*

    play and children's development. Paper presented at Young Children and Learning

    Technologies (IFIP 3.5). Retrieved from:

    http://crpit.com/confpapers/CRPITV34Verenikina.pdf

Williams, J. P., Hendricks, S. Q., & Winkler, W. K. (2006). *Gaming as culture, essays on*

    reality, identity and experience in fantasy games. Oxford University Press: McFarland &

    Company.

World Economic Forum (2015). *New Vision for Education: Unlocking the Potential of*

    Technology.

Yoon, B., Rodriguez, L., Faselis, C. J. & Liappis, A.P. (2014). Using a board game to

    reinforce learning. *The Journal of Continuing Education in Nursing, 45*(3), 110-111.

Zenasni, F. & Lubart, T. (2002). Effects of emotional states on creativity. *Current Psychology*

    Letters: Behaviour, Brain & Cognition, 8, 33-50.

Appendix

Deutsch rules

Each player is dealt 4 cards, face down. They can look at two of them before the start of the game. The first player draws a card from the draw pile and places it in the discard pile, face up. Each player has two choices: either exchange the top card of the discard pile with one of his/her cards or draw a card and place it on top of the discard pile. At every moment, any player can discard one of his/her cards if its value matches the top card of the discard pile. However, if the player gets it wrong, he/she must take it back and is dealt another card, face down. At the end of the turn, a player can call "Deutsch", upon which the game will end after the next turn. Each red face card has a once-per-game specific "power", which is activated when they appear face up: the jack allows the player to exchange two player's cards, the queen to peek at another card, and the king's value is 0.

Qwixx rules

The first player must throw the six dice simultaneously and will then have two actions to do. First, he or she adds up the value of the two white dice and announces it to the others: each player can cross out this number, in any row they want. Second, the player can add up the value of a white die and of a colored die, to cross out the number in the corresponding colored row. If the current player can not execute either of these two actions, the player must cross out one the four "missed shot" cases. To cross out the last number of a row (2 or 12 depending on the color), a player must have already crossed out at least five numbers in this row: doing this closes the row for every player, meaning it is impossible to cross out a number in the now closed row. The game ends when at least two rows are closed or when a player has crossed out the four "missed shot" cases.

Table 1.

Descriptive statistics

	Type of game	Pre-test fluency	Post-test fluency	Pre-test originality	Post-test originality
Mean	Creative	5.02	4.96	3.99	4.15
	Non-creative	4.86	5.09	3.82	4.03
Standard deviation	Creative	2.17	2.09	1.31	1.09
	Non-creative	2.47	2.34	1.15	1.04

Figure 1.

Change in originality score from the pre-test to the post-test, for creative board games (CBG)
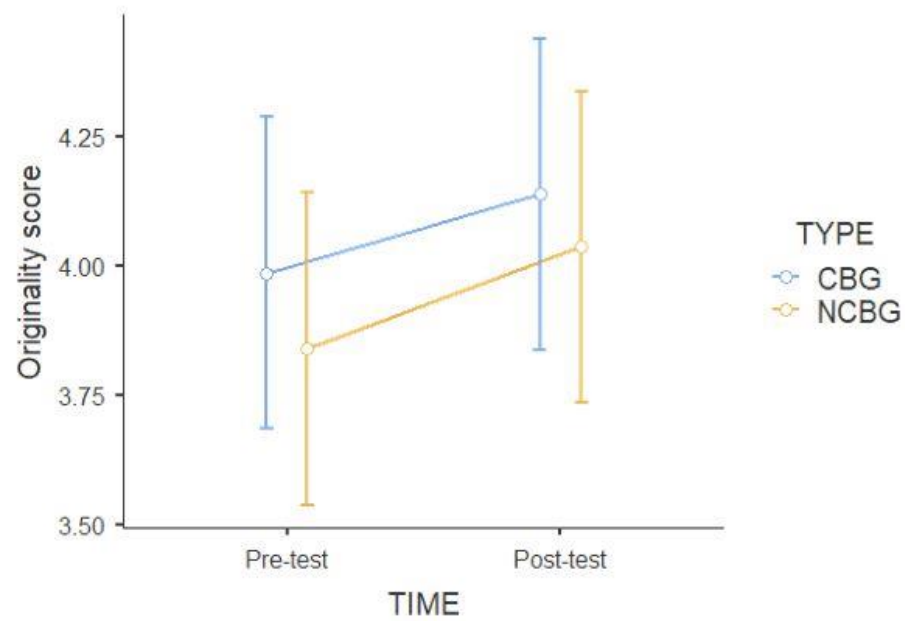*and non-creative board games (NCBG)*

Figure 2.

Changes in fluency and originality scores from the pre-test to the post-test, for low and high performing participants