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Exploring the effects of age, gender and school setting on children's creative thinking skills

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Abstract

The current study aims to investigate whether age, gender and testing environment may have an effect on children creativity in a real life setting. Participants included 111 children aged from seven to eleven years old. They were given one verbal (Guilford's Alternative Uses Task) and one figural creative thinking task (Test for Creative Thinking – Drawing Production) either in their everyday Classroom or in their school “art room”. On average, in the verbal task, girls tended to outperform boys in fluency, and flexibility. Contrary to the 4th grade slump found in previous studies, divergent thinking, on average, increased with age for verbal originality, and verbal elaboration. These results suggest the potential importance of experience on verbal creativity tasks. In the verbal task, for the originality score, and in the drawing task, participants in the art room, displayed, on average, greater levels of creative thinking than those in the Classroom. These findings suggest that the physical environment can affect differently children's creative potential.

Keywords: Creativity; 4th grade slump; Divergent thinking; contextual variables

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The phenomenon of creative thinking is usually characterized by its novelty and its usefulness (Gardner, 1988; Guilford, 1950; Runco & Jaeger, 2012; Sternberg, 2005). For many years, psychologists have considered creative thinking as an essential educational process (Bloom, 1956; Craft et al., 2001; Dewey, 1933) potentially influencing psychological well-being (Leckey, 2011) and enhancing decision-making skills (Forgionne & Newman, 2007). However, it is still unclear how internal factors such as age and gender, and external factors such as context and sensory modalities may affect creative thinking.

There is strong evidence suggesting the existence of a critical period in the first years of life where children are considered to be in a creative stage of development (Charles & Runco, 2001; Torrance, 1968). Torrance (1967) identified the “fourth grade slump”, a visible drop in creativity occurring around the age of nine years old. This phenomenon may be accompanied by a slump in the development of literacy skills making it even more difficult for children to achieve their true academic potential (Chall & Jacobs, 2014). However, it is also important to note researchers have found variations across ages, grades, cultures, and measures (Charles & Runco, 2001; Lau & Cheung, 2010; Storme et al., 2017), including some evidence of children experiencing a slump rebounding in later grades (Barraza et al., 2019) and other showing no "effect" at all (Charles & Runco, 2001).

Several studies have investigated biological as well as social factors responsible for this phenomenon. For instance, creativity positively correlates with the resting state of the prefrontal cortex (Wei et al., 2014). Accordingly, the development of prefrontal area at the age of six years old could help explain why children may be more creative at a younger age (White, 1970). Another reason given for the drop in creative expression is that children may become more conventional around the fourth grade, and would devote more attention to peer reactions instead of self-expression (Runco, 1999).

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Variations in creativity scores have also been associated with gender. In fact, several studies revealed that both genders have their relative strengths and weaknesses in creative thinking. Girls, on average, tend to perform higher on thoroughness of thinking and elaboration, and boys better in boundary-breaking thinking and flexibility (Besançon & Lubart, 2008; Clark & Goldman-Rakic, 1989; He & Wong, 2011). However these findings are not always replicated and may depend on the participants' culture, as well as the context in which children are tested

Studies which have looked at the effect of the slump across different cultures generally agree that the phenomenon is not universal, and creative abilities can be affected by cultural and environmental factors (Al-sulaiman, 2009; Torrance, 1967). Very early Torrance (1967) suggested that the preliminary cause of the "fourth grade slump" could be the enlarged amount of culturally determined social demands expected around the age of 9. More specifically, Torrance (1968) proposed that one of the main social demands imposed on children is conforming to classroom standards. Once children start school, the structure of the new standardised environment may prime awareness of their behaviour, leading to the prevention of trying new things and suppressing creativity (Lau & Cheung, 2010). Accordingly, Swedish students commencing regular schools at the age of seven were outperformed by those aged six in creative tasks (Smith & Carlsson, 1983). In the same vein, Thomas and Berk (1981) found that across nine different schools, 6-year-old children displayed a greater amount of creativity when they were in an informal school environment. Furthermore, Yi, Hu, Plucker and McWilliams (2013) identified that the ages at which the creativity slumps occur in Chinese students is associated with the academic pressure of school entrance exams. In contrast, alternative pedagogies such as Montessori seem to have a positive influence on creative development (Besançon & Lubart, 2008). Interestingly, adult

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participants as well show higher creativity score when tested in a disorderly environment rather than in an orderly one (Vohs et al., 2013).

Finally, modalities can also play a role. In fact, creativity in one modality may not transfer to other modalities. For instance, one could be very creative when painting while another will be creative when dancing. This matter of fact is mirrored by the diversity of measures and way to approach creativity (Said-Metwaly et al., 2017). For this reason, one of the main standardized ways to assess creativity is based on the Torrance Tests of Creative Thinking, which come in two modalities, figural and verbal. Having two tests may allow the measurement of two different and maybe unrelated creative skills, and to limit any linguistic bias which may hide spatial or problem solving talents (Plucker & Renzulli, 1999). By exploring verbal and figural types of creativity intervention, a recent study suggests that while verbal training could increase both verbal and figural divergent thinking abilities, the figural training only seem to affect picture painting tasks (Fink et al., 19). This work confirmed the importance to consider modalities when exploring domain-general or domain-specific creativity processes.

The present study aims to test the relationships among these diverse factors in a real life setting, a school with children aged from 7-11 years old. The present study was conducted in a British Catholic Primary school near the City Centre. Children were tested either in an informal (art room, where they are used to making art works) or a formal setting (classroom, where they are used to doing more academic works). We will explore how age, gender and the type of room may be associated with one verbal-written and one figural-drawing divergent thinking test.

Method

Participants

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A total number of 111 participants were tested ranging from the age of 7 to 11 years old ($M= 8.73$ years, $SD=1.52$). They were divided in two groups “7-8 years olds” ($N=48$) and “9-11 years-old” ($N=63$). Of these participants, 54 were girls and 57 were boys. All participants were children currently studying in primary school from Years 4 to 6, equivalent to US grades 3-5. This research was carried out in accordance with the ethical standards of the University of Portsmouth (2017-063).

Design

Participants from each class were randomly divided into two groups. One group of students took part in the experiment in the school art room and the second group of students was in the classroom. Participants in the classroom condition sat at tables as they would on a day-to-day basis, whereas participants in the art room stood behind a worktop, in the same manner they do during art class. The art room was decorated with painted foam shapes and buntings to add colour (Figure 1).

Each condition involved three tasks: two drawings (A and B) and one verbal (written) task aiming to measure divergent thinking. To ensure all measures were controlled a stopwatch and standardised instructions were used. The verbal task (Ping Pong task) was conducted in the middle of the two drawing tasks to ensure a break between the similar tasks, and to prevent boredom.

Materials

Davis (1995) suggested that when testing creativity two tests should be used in order to minimise false negatives, which may arise when measuring creativity with a single test. Thus, two tests of this manner were used, the Urban and Jellens’ (1996) Test for Creative Thinking – Drawing Production (TCT-DP), and the Guilford’s Alternative Uses Task (1967).

In the TCT-DP test each participant was given two drawings to complete. The TCT-DP Manual by Urban & Jellen (1996) was used to conduct and code the drawings. For the

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Guilford's Alternative Uses Task, a Ping Pong ball was used. Each participant had to write down the different uses this ball could have.

Procedure

Prior to the experiment, an opt-out informed consent form was sent home by the school to the parents. Attached to this was the participant information sheet and a cover sheet, provided by the school. This was sent out two weeks before conducting the experiments providing enough time for the parents to withdraw their child if they wished.

During the experiment, participants were seated around tables ensuring there was space between each child to avoid copying. Due to school policy and children's comfort a teaching assistant was present in the room during the experiment. She was instructed only to step in if any child displayed disruptive behaviour. Pencils were provided, with no colour on the reverse end. Participants were then given Drawing A and instructed to write their age and gender at the top. Then, they received the following instructions: "In front of you is an incomplete drawing. The artist who started it was interrupted before he or she was able to finish it. I would like you to finish it off. You are allowed to draw anything you wish and nothing you do is wrong. Everything you put on the paper is correct. If you know a name or theme for your drawing please write it above your drawing. Do not worry about the time, but we do not have a whole hour to finish it. You are only allowed to use the pencil provided in front of you. When you do finish it just raise your hand, so that I can take it away. Do you have any questions?"

As the participants in the Classroom setting asked more questions to reassure themselves it was "correct", we followed the procedure demonstrated in the TCT-DP manual. They were told "Nothing you do is wrong, everything you put on the paper is correct". Participants then began the task and as each one finished, their drawing was collected and

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their time of finish was marked at the top. Participants were cut off at a 15-minute mark if they still had not finished.

Following this, the children participated in the ping pong ball task. In the Art room, participants were given an A5 sheet of plain paper and those in the Classroom were given an A5 sheet of lined paper, to correspond with the settings. The following verbal instructions were given: "Imagine you have a ping pong ball in front of you. I want you to write down different ways in which you could use it other than playing ping pong? You can write ten at most but if you can only think of one or two then that is ok. If you cannot think of any that is fine too."

Participants were given up to 5 minutes to complete this task, and sheets were collected, and Drawing B was given. The same method and instructions for Drawing A was then repeated for Drawing B.

Coding

Guilford's Alternative Uses Task (Guilford, 1967) was used to code the results from the ping pong ball task. The following criteria were used: Fluency, Originality, Flexibility and Elaboration. Fluency marks were given for every answer written on the sheet with a cut-off point at ten points. For originality, each answer was compared to the total amount of answers from the people tested, answers given by 5% were given one point and answers given by only 1% showed uniqueness, awarding them two points. Since higher fluency artificially increase the originality, we used the corrective calculation for originality ($\text{originality} = \text{originality}/\text{fluency}$). Regarding flexibility, one point was given for each different types of categories. Points were awarded for elaboration based on the amount of detail given in an answer; for example "wrap it up" = 1 whereas "wrap it up in a lindt

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wrapper" = 2 (one point for the detail about lindt paper), and "wrap it up in a lindt wrapper to prank your mum" = 3 (one additional point for further detail about the hidden goal)¹.

The drawing tasks were coded to obtain a score for each child. Coding followed the guidelines provided by TCT-DP manual, ensuring everything was standardised (Urban & Jellen, 1996). To ensure all scores were given in the correct manner a reliability test was conducted. In this, ten drawings were given to an assistant researcher so that they could mark them using the TCT-DP criteria. Since we had two raters, we used a Pearson correlation as a valid estimator of interrater reliability. This inter-observer reliability test showed $r = 0.899$, suggesting high reliability for the markings of the scores.

Data Analysis

Univariate factorial Analyses of Variance (ANOVA) were conducted on the TCT-DP scores and on the four variables of Ping Pong task (Fluency, Originality, Flexibility and Elaboration). Due to these five calculations on the same data, we lowered the α -value using the Bonferroni method ($\alpha' = 0.05/5 = 0.01$). Following the convention, we considered as tendencies p-values equal to twice the α' -value (i.e. 0.02). The main effects of "condition", "gender", "age" and the diverse two-way interactions were included.

Results

Guilford Alternative Uses Task

Fluency

Only one child got a score of 10. The Median score for our sample was 4. Girls, on average, perform significantly more creatively (Mean=4.45±1.88) compared to boys

¹ Note: When reviewing our data during our revision of this manuscript, we found and corrected some errors in the way some of our data were coded. We re-ran the analyses for this version of the article. Previous significant differences were still significant. The only major change was that we also found an effect of the art room on our verbal tasks (for the originality score); making some sections of our discussion about modalities in the initially reviewed version obsolete. We also removed the discussion of a couple of interactions which were initially considered tendencies, before using the Bonferroni correction. To ensure transparency, all the data have been made available online in an open repository <https://doi.org/10.17029/122918f6-183b-4d87-87c1-c91aa8588ab0>

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(Mean=3.29±1.8) in both environments ($F=13.775$, $p<0.001$, $\eta^2=0.117$; Table 1). However, no significant effects were found for room ($M_{\text{art room}}=4.07\pm1.85$; $M_{\text{classroom}}=3.65\pm1.99$) or age ($M_{7-8}=3.60\pm1.99$, $M_{9-11}=4.06\pm1.86$); and for the interactions.

Originality

Age had a significant effect on the originality scores with 7-8 years-olds showing, on average, lower originality score (Mean=0.16±0.25) compared to 9-11 years-olds (Mean=0.46±0.53; $F=14.569$, $p<0.001$, $\eta^2=0.123$; Table 1). Scores tended to be higher, on average, in the art room ($M_{\text{art room}}=0.41\pm0.47$) compared to the class room ($M_{\text{classroom}}=0.25\pm0.43$; $F=5.410$, $p=0.022$, $\eta^2=0.049$). No significant effect was found for gender ($M_{\text{boys}}=0.33\pm0.52$; $M_{\text{girls}}=0.33\pm0.39$); and for the interactions.

Elaboration

Age had a significant effect on the elaboration scores with 7-8 years-olds showing, on average, lower elaboration score (Mean=0.08±0.20) compared to 9-11-years-olds (Mean=0.23±0.31) ($F=8.927$, $p=0.004$, $\eta^2=0.079$; Table 1). No significant effects were found for rooms ($M_{\text{art room}}=0.17\pm0.29$; $M_{\text{classroom}}=0.16\pm0.28$), gender ($M_{\text{boys}}=0.14\pm0.25$; $M_{\text{girls}}=0.19\pm0.31$) and for the interactions.

Flexibility

Gender had a significant effect on the flexibility scores (Table 1). On average, the flexibility score was higher for girls (Mean=2.36±0.95) compared to boys (Mean=1.89±0.85; $F=8.378$, $p=0.005$, $\eta^2=0.075$; Table 1). No significant effects were found for age ($M_{7-8}=1.96\pm0.92$; $M_{9-11}=2.25\pm0.92$) or rooms ($M_{\text{art room}}=2.19\pm0.99$; $M_{\text{classroom}}=2.06\pm0.86$), or the interactions.

TCT – DP

Room had a significant effect on the TCT-DP scores (Table 2). Children, on average, were more creative in the art room (Mean score = 55.85 ± 15.29) than in the classroom

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(Mean score = 42.02 ± 14.24 ; $F=22.176$, $p<0.001$, $\eta^2=0.176$). No significant effects were found for age ($M_{7-8}= 49.73 \pm 15.61$; $M_{9-11}=48.63\pm 16.87$), gender ($M_{\text{boys}}=49.91\pm 15.02$; $M_{\text{girls}}=48.26 \pm 17.59$) or the interactions.

Discussion

In the verbal task, girls tended to outperform boys in fluency, and in flexibility. On average, 9-11 years olds showed higher scores for originality, and elaboration. Students in the art room tended to have higher originality scores regardless of age and gender. In the drawing task, while gender and age had no significant relationship, participants in the art room, displayed greater levels of divergent thinking than those in the Classroom.

Regarding gender differences, our results may, in part, be explained by prior work which has indicated girls' appeared to show more thorough thinking (He & Wong, 2011), and written orthographic fluency (Berninger & Fuller, 1992). In fact, we only found a gender effect in the verbal task, and only for the flexibility and fluency components. To gain points in these areas, participants had to give a variety of detailed verbal ideas.

The expectation of there being a drop in divergent thinking at the age of nine was not found in either tests. On the contrary, it increased with age in the verbal domain for the originality, and the elaboration components. A possible reason for no slump occurring may be the fact that all children tested stayed in the same school building. Students in other studies, moving at that age to regular schools, may have displayed greater levels of stress augmenting the creative slump (Smith & Carlsson, 1983). Our data would then support environmental and social causes as being more important than biological ones in explaining creative slumps. Interestingly, the components positively affected by age (originality and elaboration) could also be affected by the breadth of knowledge possessed by the participants. In fact, previous studies argued that speed and learning experience can also affect individuals' creativity at different points in life (Craik & Bialystok, 2006), and that a rich

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amount of knowledge is necessary to feed creativity (Amabile, 1983; Dane, 2010; Mednick, 1962; Simonton, 2003; Thagard & Stewart, 2010). It is worth noting that better handwriting as well as increase in academic stamina may have also played a role in making the written creative task easier for older pupils. If the task was verbally spoken, the results may have been different.

Regarding the rooms, levels of divergent thinking in the art room may have been higher for the verbal task in the originality domain and for the figural task because of the more comfortable feeling elicited by this setting. These findings matched previous research proposing that a less formal environment leads to greater creativity, no matter the age (Thomas & Berk, 1981; Vohs et al., 2013). We can hypothesise that children could have felt freer in the less formal educational environments (Lau & Cheung, 2010). It is also worth noting that children had past experience in this room which, through Pavlovian conditioning, may have elicited a more positive and creative mindset. The fact that only originality was affected in the verbal task suggests that the quality of a physical environment can prime differently children's cognitive abilities according the modalities in play. In order to investigate these ideas further, looking at the relationship between the environment and the modality used could be useful. For example, creative skills in kinaesthetic modalities such as modelling with clay or dancing may also be more positively affected by the art room compared to the writing modality. Alternatively, the more colourful visual environment offered by the art room may have also played a role. Future research could also investigate how environmental complexity may affect creative skills in children.

Our sample size was large compared to previous experimental studies on this topic. However, there are still some limitations that need to be recognised. Since we investigated three between-subjects variables, inter-individual variability may have masked some of the effects, especially possible interactions, resulting in false negatives. Nonetheless, this study

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managed to show significant effects in line with the existing literature and deserving further investigations. Future studies could replicate this work with larger group sizes or focusing on one variable more specifically.

Secondly, results may have been influenced by the individual's family economic experience and social position within society. Social economic status and cultural backgrounds may have strong influences on how age, gender or environment can affect a child cognitive abilities. It could be that those with a higher social position within society show more creative thinking skills than those that are not, or vice versa. Future studies may consider giving questionnaires to parents to get an idea of their socio-economic status and cultural backgrounds.

Thirdly, it is worth noting that environment may affect differently children according the type of task and the individual's characteristics. Observing different modalities may provide valuable information. For instance, it could be that a kinaesthetic modality and/or an outdoor environment would have been used, results regarding age or gender would have been totally different.

Finally, it is worth noting that the norm of a competitive environment may have affected some children, as they may have rushed to finish first. Thus, future studies could also investigate whether testing participants individually in a room on their own may produce different results; and if so identify specific personality traits predisposing for environmental influences on creativity.

This study highlights how environment associated with creative tasks can enhance verbal and figural creative skills in children. Future studies, exploring alternative environments and other modalities may provide precious information to parents and teachers. This can help them when customizing diverse activities' settings or creativity trainings in order to optimize the creative skills of specific groups of children in specific domains (Fink et

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al., 19). Enhanced opportunities to develop creative skills has the potential of enhancing educational results, psychological well-being and decision-making skills.

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Table 1

Factorial analysis of variance for the verbal task

	F	P-value	η_p^2
Fluency score			
Room	2.843	.095	.027
Gender	13.775	.000	.117
Age	1.832	.179	.017
Gender x Age	3.946	.050	.037
Age x Room	.392	.533	.004
Gender x Room	.004	.947	.000
Originality score			
Room	5.410	.022	.049
Gender	.059	.809	.001
Age	14.569	.000	.123
Gender x Age	1.150	.286	.011
Age x Room	.384	.537	.004
Gender x Room	1.457	.230	.014
Elaboration score			
Room	.576	.450	.006

Age, gender, school setting and creativity

Gender	.583	.447	.006
Age	8.927	.004	.079
Gender x Age	.112	.739	.001
Age x Room	1.857	.176	.018
Gender x Room	.606	.438	.006
Flexibility score			
Room	1.500	.223	.014
Gender	8.378	.005	.075
Age	3.101	.081	.029
Gender x Age	.780	.379	.007
Age x Room	.040	.841	.000
Gender x Room	4.586	.035	.042

Table 2

Factorial analysis of variance of TCT-DP scores for the figural task

	F	P-value	η_p^2
Room	22.176	.000	.176
Gender	.274	.602	.003
Age	.011	.918	.000
Gender x Age	.640	.426	.006
Age x Room	.230	.633	.002
Gender x Room	.153	.696	.001

Fig 1. Exploring the Effects of Age, Gender, and School Setting on Children's Creative Thinking Skills

