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Information technology use and creativity: Findings from the Children and Technology Project

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ABSTRACT

This research examined relationships between children's information technology (IT) use and their creativity. Four types of information technology were considered: computer use, Internet use, videogame playing and cell phone use. A multidimensional measure of creativity was developed based on Torrance's (1987, 1995) test of creative thinking. Participants were 491 12-year olds; 53% were female, 34% were African American and 66% were Caucasian American. Results indicated that videogame playing predicted of all measures of creativity. Regardless of gender or race, greater videogame playing was associated with greater creativity. Type of videogame (e.g., violent, interpersonal) was unrelated to videogame effects on creativity. Gender but not race differences were obtained in the amount and type of videogame playing, but not in creativity. Implications of the findings for future research to test the causal relationship between videogame playing and creativity and to identify mediator and moderator variables are discussed.

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1. Introduction

Creativity has been defined as a mental process involving the generation of new ideas or concepts, or new associations between existing ideas or concepts. From a scientific standpoint the products of creative thought are usually considered to have both originality and appropriateness.

Although creativity appears to be a simple concept in the parlance of everyday life, its meaning and measurement have eluded the scientific community for decades. In fact it is a very complex concept that is difficult to define and measure (Runcho & Albert, 2010). Over one hundred definitions of creativity exist in the literature, spanning a variety of disciplines (Hocevar & Bachelor, 1989; Park & Byrnes, 1984; Parkhurst, 1999). Creativity is unique among scientific phenomena insofar as there is no single, authoritative perspective or definition of creativity.

Given the diversity in conceptualizations of creativity it is no surprise that there is also diversity in how it is measured. A popular approach to the measurement of creativity is the psychometric approach, pioneered by Guilford (1967). Most creativity measures in use today are based at least in part on Guilford's theory of creativity. The theory posits that the ability to envision multiple solutions to a problem lies at the core of creativity (Guilford, 1967, 1982). The Torrance Test of Creativity (Torrance, 1987) is based on Guilford's theory and is one of the most reliable and valid measures of children's creativity. In this research we used the Torrance Test to obtain a multidimensional measure of creativity in our 12-year old participants.

Research on the effects of using information technology has increased exponentially during the Information Age, outpaced only by the growth of information technology itself. In the previous century the primary focus was on the effects of computer-based learning on children's cognitive development (Wartella & Jennings, 2000). This line of research was quickly replaced by research on Internet effects, ignoring the fact that the computer is the primary vehicle for delivering the Internet, although the handheld may soon take the lead. The Pew Internet and American Life Project holds what is probably the most comprehensive set of national (US) survey research on the who, what, where, when and why of Internet use (e.g., Pew Internet and American Life Project, 2005, 2006, 2007).

Videogames effects have been a popular research topic perhaps because playing videogames is a popular activity. According to the Entertainment Software Association (2011) 72% of American households play video or computer games. Both "good news" and "bad news" have emerged from the research. On the positive side, videogame playing has been related to visual-spatial skills (Green & Bavelier, 2003, 2006, 2007), skills which may be linked to performance in mathematics, engineering and science (Subrahmanyam, Smahel, & Greenfield, 2006). One experimental study

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suggested a causal relationship between videogame playing and visual-spatial skill in adults (Green & Bavelier, 2007). A recent correlational study suggested a positive relationship between videogame playing and visual-spatial skills in children (Jackson, von Eye, Fitzgerald, Witt, & Zhao, 2009). On the negative side, videogame playing has been linked to aggressive cognition and behavior in children and adults (Anderson, Gentile, & Buckley, 2007; Bushman & Anderson, 2002; Gentile & Anderson, 2003; Gentile, Lynch, Linder, & Walsh, 2004). A handful of studies have demonstrated a causal relationship (e.g., Anderson et al., 2003). However, as gaming enthusiasts were quick to point out, the effect size for the relationship between videogame playing and children's aggression is half the effect size for the relationship between watching violent TV and children's aggression (Gee, 2005).

Jackson and colleagues summarized the research on the cognitive, social, psychological and physical consequences of Internet use for children (Jackson, Zhao, Fitzgerald, von Eye, & Harold, 2006) and adolescents (Jackson, 2008). Most of the studies included in these summaries were correlational studies. Whether using the Internet *causes* real changes in cognitive, social, psychological and moral thinking and/or behavior remains an unanswered question. Even the much discussed relationship between Internet use and obesity is likely mediated by other factors (e.g., creen time versus activity time).

Research has only quite recently turned its attention to cell phones. The questions addressed vary widely, ranging from "Does using a cell phone increase the probability of developing brain cancers?" to "Are cell phones decimating your social life?" At this early stage of studying a rapidly changing technology the only conclusion that can be drawn is that cell phones should not be used while driving. They divert attention away from the driving task and use up cognitive resources needed for that task (Butt & Phillips, 2007; Cell Signs Report: Text Message Statistics, 2008; Nielson Mobile, Neilson Company, NY: NY, retrieved August 3, 2011, from http://www.cellsigns.com; Pew Internet and American Life Project, 2010, 2011).

In this research we took an exploratory approach to examining relationships between a complex and important concept – creativity, and a variety of information technologies, specifically, computers, the Internet, videogames and cell phones. Because so little is known about the causes of creativity, and because so little is known about the effects of IT use, examining their relationships is an important first step in understanding both. We were particularly interested in the relationship between videogames playing and creativity because playing videogames has become a core activity in the lives of today's children (Entertainment Software Association (2011) and, most likely, tomorrow's adults. The average age of videogame players is 37 years old (Entertainment Software Association, 2011).

2. Materials and methods

2.1. Participants and procedures

Participants were 491 children, average age 12.34 years old, who completed surveys containing the creativity measures and the technology use measures as part of their participation in the Children and Technology Project (NSF-HSD # 0527064). Child participants and their parents were recruited from 20 middle schools geographically distributed in the southern lower peninsula of Michigan. An additional 100 participants were recruited from YouthVille Detroit, and after-school center for underserved groups in Detroit. About half (53%) of the participants were female, 34% were African American and 66% were Caucasian American. Four types of information technology were considered: computer use, Internet use, videogame playing and cell phone use. Multiple measures of creativity were develop using Torrance's (1987, 1995) test of creative thinking.

Surveys were mailed to participants' parents and returned in stamped, pre-addressed envelopes. Participants' parents also completed surveys and were compensated $25 when both the completed Parent Survey and Child Survey were returned. Parents who returned surveys were eligible to participant in a raffle for a grand prize drawing of $500. Response rate was 65%.

2.2. Measures

2.2.1. Creativity

The Torrance Test of Creativity – Figural (Torrance, 1987) was the basis for constructing a multidimensional measure of creativity with two objectives in mind. The first was to capture the richness and complexity of the creativity construct. The second was to minimize the contribution of alternative constructs to the creativity measure. In particular, creativity measures have been criticized for being saturated with the generalized intelligence factor, "little g" (e.g., Cooper, 1991; Fleenor & Taylor, 1994; Hocevar & Bachelor, 1989; Sternberg, 2001; Torrance, 1988, 1995; Treffinger, 1985). Every effort was made to minimize the contribution of little g to our measures of creativity while acknowledging that any measure requiring a verbal/written response will to some extent be influenced by generalized intelligence.

Participants responded to two target stimuli to assess creativity. The first stimulus took the form of an "egg" presented alone on a blank sheet of paper. Instructions were as follows:

> On the following page is a curved shape. Think of a picture or object that you can draw with this shape as a part of it. Try to think of a picture that no one else will think of. Keep adding new ideas to your first idea to make it tell as interesting and exciting a story as you can. When you have completed your picture make up a name or title for it and write this in the space provided under your picture. After you have drawn your picture and given it a title, come back to this page and write a story about your picture in the space below.

The second stimulus was a picture of an elf-like figure lying in front of a small pool of water, staring at its reflection in the water. Instructions were as follows:

> Look at the picture. Think about what is happening. What can you tell is happening for sure? What do you need to know to understand what is happening, what caused it to happen, and what will happen next, as a result? After you have looked at the picture and thought about these questions then go to the next page, after the picture.

The next three pages contained the following instructions:

> Write out all of the QUESTIONS you can think of about the picture. Ask all the questions you need to ask to know for sure what is happening. Do not ask questions that can be answered just by looking at the picture. You can look back at the picture as much as you want to.
> List as many possible CAUSES as you can think of for the activity (what is happening) in the picture. You may use things that might have happened just before the things that are happening in the picture, or you can use things that happened a long time ago that made the things in the picture happen. Make as many guesses as you like. Don't be afraid to guess. You can look back at the picture as much as you want to.
> List as many POSSIBILITIES as you can think of for what might happen next as a result of what is happening in the picture. You may use things that might happen right afterward, or you

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can use things that might happen long afterward, in the future. Make as many guesses as you can. Don't be afraid to guess. You can look back at the picture as much as you want to.

2.2.2. Technology use

In a separate section of the Child Survey participants indicated the extent of their technology use on a 7-point scale where 1 = not at all, 2 = about once a month, 3 = a few times a month, 4 = a few times a week, 5 = everyday, but for less than 1 h, 6 = everyday, for 1–3 h, and 7 = everyday, for more than 3 h. Measures were obtained for computer use, Internet use, videogame playing and cell phone use. Participants were also asked to indicate their favorite videogame in the blank space provided.

2.2.3. Socio-demographic characteristics

In the first section of the Child Survey participants indicated their gender, race/ethnicity and age. Only those participants who indicated that their race/ethnicity was African American or Caucasian American are included in the analyses that follow (i.e., 491 of the 591 child participants). Information about household income was obtained from the Parent Survey. Parents indicated their total net annual household income using the following scale: 1 = under $20,000, 2 = $20,000–49,999, 3 = $50,000–79,999, 4 = $80,000–99,000, 5 = $100,000–149,999, 6 = $150,000–200,000, 7 = over $200,000.

2.3. Preliminary analyses

2.3.1. Creativity

Children's open-ended responses to the creativity stimuli (Egg and Elf) were coded by six trained undergraduates supervised by a trained graduate student. Coding was based on the following categories and scales suggested by Torrance (1987, 1988): *Egg story creativity*: *Overall creativity* (1 = not at all creative, 2 = creative, 3 = very creative); *Fluency* –number of interpretable, meaningful, and relevant ideas generated in response to the stimulus; *Flexibility* – number of different categories of relevant responses; *Originality* – rarity or unusualness of responses (1 = not unusual or rare, 2 = unusual and rare, 3 = very unusual and very rare); *Elaboration* – the degree of detail in the responses (1 = low elaboration, 2 = moderate elaboration, 3 = high elaboration); Mean *Number of Words* in the story. *Elf story questions creativity*: *Overall creativity, fluency, flexibility, originality, elaboration of questions*, as operationalized for the Egg Story and *Number of questions* (non-redundant). *Elf story causes creativity*: *Overall creativity, fluency, flexibility, originality, elaboration of causes*, as operationalized for the Egg Story and *Number of causes* (non-redundant). *Elf story possibilities creativity:* Overall *creativity, fluency, flexibility, originality, elaboration of possibilities*, as operationalized for the Egg Story and *Number of possibilities* (non-redundant).

Composites for each of the measures listed above were formed by averaging the ratings of the six trained undergraduate raters. Factor analyses (maximum likelihood, varimax rotation, 25 iterations, eigenvalues > 1, factor-item loadings greater than .50 with no split loadings) were used to identify underlying dimensions of the creativity ratings only (i.e., excluding the number counts which use a different scale of measurement (1 to unlimited) than the creativity ratings (all use a 1–3 rating scale). Results of the factor analyses suggested four underlying though related dimensions (65.4% of the variance). Items for these dimensions were averaged to form the following composite measures of creativity used in subsequent analyses:

Egg story creativity – mean (egg originality, egg elaboration, egg creativity), $\alpha = .94$;
Elf questions creativity – mean (questions originality, questions elaboration, questions creativity), $\alpha = .88$;
Elf causes creativity – mean (causes originality, causes elaboration, causes creativity), $\alpha = .93$;
Elf possibilities creativity – mean (possibilities originality, possibilities elaboration, possibilities creativity), $\alpha = .94$.

Also included in subsequent analyses were the average number of words in the egg story (*# EggWords*) and the average number of questions, causes, and possibilities in responses to the elf stimulus (*# QCPElf*).

2.3.2. Videogame type

Open-ended response to the request for the name of their favorite videogame resulted in 205 unique videogames from the 491 children. To determine whether only certain types of videogames were related to creativity we categorized each of the 205 videogames as follows:

First, using game descriptions provided by Wikipedia and other online gaming sources we attempted to categorize the 205 favorite games into the seven widely accepted game genres. This effort proved unsuccessful. Most of the videogames required at least two genres to describe game play. More importantly, an alternative categorization scheme might better capture the dimensions of children's game play that are important to predicting children's outcomes of game play, such as creativity. Thus, a child's favorite videogame was placed into one of the following mutually exclusive categories:

(1) *Violent videogames*. Games in this category include first-person shooter games and games in which violence is at the core of game play. Games named by participants that fell in this category are Zelda and Super Smash Brothers.
(2) *Action–adventure videogames*. Games in this category typically involve role-playing, strategy and problem-solving to "win" the game. Examples of games in this category for our participants are Half-Life 2 and Star Wars.
(3) *Racing/driving videogames*. Driving and race simulation games fall into this category. Examples are Need for Speed and Big Mutha Truckers II.
(4) *Sports videogames*. Games in this category include all types of sports/athletic games. Among our participants the most popular games in this category were NBA basketball and NFL football.
(5) *Interpersonal videogames*. Games that involve interpersonal relationships or caring for others, humans or non-humans, were included in the category. Examples from our participant are Sims and Animal Crossing.
(6) *Other videogames*. Games that did not fit into any or the preceding five categories were placed in this category. Examples are Parkalline and Spider Solitaire.

3. Results

3.1. Relationships between creativity and technology use

Correlations between the six measures of creativity and four measures of technology use are presented in Table 1. To minimize the likelihood of Type 1 errors a significance level of .01 was adopted. Even with this more stringent criterion, correlations between videogame playing and every measure of creativity were significant and positive. Children who played videogames more scored higher on Egg story creativity, Elf questions creativity, Elf causes creativity, Elf possibilities creativity, # Egg words and # QCP Elf words. No other technology use measure was related to

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Table 1
Correlations between creativity and technology use.

	1	2	3	4	5	6	7	8	9	10
1. Egg story creativity	1									
2. Elf questions creativity	.65*	1								
3. Elf causes creativity	.52*	.72*	1							
4. Elf possibilities creativity	.58*	.59*	.71*	1						
5. # words Egg story	.45*	.38*	.47*	.42*	1					
6. # QCP elf stories	.35*	.44*	.49*	.33*	.55*	1				
7. How often do you use a computer?	.12	.13	.06	.14	.15	.10	1			
8. How often do you use the Internet?	.02	.05	.00	.08	.10	.10	.66*	1		
9. How often do you play videogames?	.59*	.40*	.44*	.49*	.47*	.27*	.20*	.04	1	
10. How often do you use a cell phone?	−.12	−.06	−.10	−.09	−.09	−.11	.08	.13	−.06	1

Note. *N*s for the analyses ranged from 273 to 391.
* $p < .01$.

Table 2
Predicting creativity from technology use.

	Egg story creativity	Elf questions creativity	Elf causes creativity	Elf Possibilities creativity	# words Egg story	#QCP Elf story
Computer use	.02	.02	−.05	−.01	.01	−.03
Internet use	.01	.03	.04	.09	.11	.13
Videogame playing	.50*	.35*	.41*	.43*	.39*	.23*
Cell phone use	−.08	−.02	−.07	−.06	−.07	−.11
Adjusted R^2	.26*	.16*	.16*	.19*	.18*	.06

Note. $N = 391$. Values are standardized beta coefficients.
* $p < .01$.

creativity. Specifically, computer use, Internet use and cell phone use were unrelated to any measure of creativity. As expected, creativity measures were related to each other. Computer use was related to Internet use and videogame playing. Cell phone use was related to Internet use only.

Next we examined relationships between creativity and socio-demographic characteristics to determine whether correlations between videogame playing and creativity might be attributable to correlations between these measures and participants' gender, race/ethnicity, age or family income. Gender was unrelated to any measure of creativity. Race was related to income ($r = .33$), and to one measure of creativity, Elf questions creativity ($r = .14$, $p < .05$). African American children came from lower income families than did Caucasian American children. Income was also related to Elf questions creativity ($r = .20$. $p < .01$); higher incomes were associated with greater creativity.

3.2. Predicting creativity from technology use

Hierarchical regression analyses were used to predict each measure of creativity from each type of technology use. Race and income were controlled (i.e., entered in Step 1) only for the creativity measure that was related to these socio-demographic characteristics (i.e., Elf questions creativity). Results are presented in Table 2.

Videogame playing was the sole predictor of Egg story creativity. Elf causes creativity, Elf possibilities creativity, # words in egg story, # QCP in response to the elf stimulus. Videogame playing to predicted Elf questions creativity even after controlling for the effects of income (std $\beta = .22$, $p < .01$). Moreover, the race effect on this measure was reduced to non-significance when income was controlled ($p > .10$, ns).

To strengthen the inference that videogame playing is a unique predictor of creativity, regression analyses were used to examine the predictive ability of the four socio-demographic characteristics for each measure of creativity. None of the regression equations was significant at the more stringent level of $p < .01$. Thus, gender, race/ethnicity, age and family household income did not predict the creativity of our 12 year-old participants, regardless of how creativity was measured. Family household income did predict creativity but only two of the six measures – Egg story creativity (std $\beta = .12$) and questions about the Elf story (std $\beta = .15$).

3.3. Creativity and videogame type

Correlations between creativity and each of the six types of videogames are presented in Table 3.

All types of videogames were strongly related to all measures of creativity except Racing/Driving games, which were related only to two of the six measures of creativity: Elf possibilities and number of words in the Egg story. Thus, regardless of the type of videogame that children played, more play was associated with greater creativity.

We also examined gender and race differences in type of favorite videogame. The gender effect was significant, $\chi^2(5) = 75.96$, $p < .001$, but the race effect was not, $\chi^2(5) = 8.56$, $p < .128$.

Inspection of the frequencies in Table 4 indicates that males were more likely than females to play violent videogames and sports videogames, whereas females were more likely than males to play interpersonal games or games that did not fit into any of

Table 3
Correlations between creativity and type of videogame.

Videogame type	All	1	2	3	4	5	6
N	395	59	50	21	39	40	40
1. Egg story creativity	.65*	.64*	.75*	.28	.44*	.78*	.55*
2. Elf questions creativity	.46*	.28†	.46*	.17	.42*	.74*	.46*
3. Elf causes creativity	.49*	.39*	.49*	.35	.43*	.65*	.51*
4. Elf possibilities creativity	.51*	33*	.68*	.45†	.36†	.70*	.40*
5. # words Egg story	.51*	48*	.54*	.44†	.49*	.52*	.63*
6. # QCP elf stories	.33*	.30†	.30†	.09	.28	.40*	.38†

Note. *N* = sample size. For videogame type, 1 – violent videogames, 2 – action/adventure videogames, 3 – racing/driving videogames, 4 – sports videogames, 5 – interpersonal videogames, 6 – other videogames.
† $p < .05$.
* $p < .01$.

Table 4
Type of videogame by gender and race.

Videogame type	1	2	3	4	5	6
N	87 (22%)	78 (20%)	41 (10%)	78 (20%)	57 (14%)	54 (14%)
Males	60 (28%)	41 (19%)	22 (10%)	63 (30%)	9 (4%)	16 (8%)
Females	27 (15%)	37 (15%)	19 (10%)	15 (8%)	45 (25%)	41 (22%)
African American	24 (20%)	24 (20%)	10 (8%)	34 (28%)	13 (11%)	16 (13%)
Caucasian American	63 (23%)	54 (20%)	31 (11%)	44 (16%)	41 (15%)	41 (14%)

Note. *N* = sample size. Values are frequencies and percentages for each gender/race category. For videogame type, 1 – violent videogames, 2 – action/adventure videogames, 3 – racing/driving videogames, 4 – sports videogames, 5 – interpersonal videogames, 6 – other videogames. Gender: $\chi^2(5) = 75.96$, $p < .001$. Race: $\chi^2(5) = 8.56$, $p < .13$.

the videogame categories. Males and females were equally likely to play strategy videogames and racing/driving videogames. Also evident from Table 4 is that racing/driving videogames were the least popular games in this sample of 12-year old children.

4. Discussion

Using a sample of almost 500, 12 year-old children we found that videogame playing was related to multiple dimensions of creativity, regardless of the type of videogame played. Computer use, Internet use and cell phone use were unrelated to any measure of creativity. Despite the relationship between gender and videogame playing (Gentile, 2009; Jackson, 2008), with males playing videogames more than do females, there was no relationship between gender and creativity. Nor was there a relationship between race and creativity.

Decades of research have been devoted to developing an appropriate conceptualization of creativity and an appropriate instrument to measure it. In this research we used one of the most reliable and valid measures of creativity in children, the Torrance Test of Creativity (Torrance, 1962). In the tradition of Guilford (1982), Torrance (1987) operationalized creativity as consisting of both the number and nature of descriptions of ambiguous stimuli, like the Egg and Elf used in our research. Reliable coding of children's open-ended responses to these stimuli was possible, and resulted in the identification of multiple dimensions of creativity, every one of which was related to videogame playing, and none of which was related to computer use, Internet use or cell phone use. Children who played videogames more were more creative, by every measure, than children who played them less, regardless of gender or race.

In addition to measuring the amount of videogame playing that children engaged in we also categorized their favorite videogame into 1 of 6 mutually exclusive categories. Gender, but not race, was related to which category of videogame was the child's favorite. Males were more likely than females to indicate that violent videogames and sports videogames were their favorites. Females were more likely than males to indicate that games involving interaction with others (human or non-human) and games that could not be categorized were their favorites. There was no gender difference in preferences for strategy videogames or racing/driving videogames. And there were no race differences in videogame preferences.

It is important to point out that our research is correlational and therefore cannot establish cause-effect relationships. Thus, we cannot conclude that being creative *causes* children to play videogames, perhaps because videogame playing satisfies some creative need. Nor can we say that playing videogames *causes* children to be creativity, perhaps because of the rich and colorful visual world of videogames, their rapidly changing scenes, and the need to hold multiple images in mind simultaneously while playing.

Technology aside, research on the correlates of creativity is still incomplete. Some studies have focused on cognitive measures like intelligence. (e.g., Simonton, 2004). Others have focused on personality characteristics like venturesomeness (Hall & MacKinnin, 1969). Many studies of creativity use participants who are selected because they are assumed to be above average in creativity (e.g., artists, authors, architects, dancers; e.g., Fink, Graif, & Neubauer, 2009).

In an effort to integrate the diverse set of findings Sternberg (2003) suggested that there are five components of creativity: (1) Expertise: a well-developed base of knowledge. (2) Imaginative thinking skills: the ability to see things in novel ways, to recognize patterns, to make connections. (3) A venturesome personality: seeks new experiences, tolerates ambiguity and risk, perseveres in overcoming obstacles. (4) Intrinsic motivation: driven more by interest, satisfaction, and challenge than by external factors. (5) Creative environment: sparks, supports and refines ideas. Creativity is related to intelligence only up to the average level of intelligence. Beyond average intelligence other factors, like those identified by Sternberg (2003), determine the level of creativity. A scholar of creativity suggested the following definition of the term:

> If I were to summarize what is most generally characteristic of the creative [individual] as we have seen him (sic), it is his high level of effective intelligence, his openness to experience, his freedom from petty constraints, and impoverishing inhibitions, his aesthetic sensitivity, his cognitive flexibility, his independence of thought and action, his high level of energy, his unquestioning commitment to creative endeavor, and his unceasing striving for creative solutions to the ever more difficult ... problems he constantly sets for himself
>
> MacKinnon, D. W. (1978, p. 3)

Does this description fit the typical videogamer? Consider the statistics. On average, videogamers are in their mid-30s, male (60%), and play 18 h a week. They tend to be overweight, introverted and susceptible to mood disorders, mainly depression. Nowhere in descriptions of a typical videogamer is the word "creative". On the other hand, research suggests a relationship between videogame playing and computation thinking (Games, 2010; Gee, 2005). Computation thinking is defined as a broad range of mental tools and concepts from computer science that help people solve problems, design systems, understand human behavior, and engage computers to assist in automating a wide range of intellectual processes (National Research Council, 2010). Like creativity, computational thinking has been difficult to operationalize (Wing, 2009). But we can speculate that computational thinking is related to creativity, and that together they facilitate interest and performance in the virtual world – the world of videogames. The effects of computational thinking and creativity on videogame playing may be additive. Alternatively, one may serve as a mediator of the other's effects. Only additional research which has carefully operationalized both creativity and computational thinking can address this issue.

To the best of our knowledge this is the first empirical demonstration of a relationship between technology use and creativity. Our findings raise a number of new questions for future research. First, are these results generalizable across a range of ages, races, and family income levels? Does the relationship between

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videogame playing and creativity transcend the boundaries of language and culture? Would a different videogame categorization scheme than the one used in this research produce similar results? Would a different measure of creativity produce similar results?

If future research establishes that videogame playing is causally related to creativity then yet another set of research questions emerge. First, what is it about videogame playing that contributes to creativity? Is it the opportunity to experience vastly different visual environments in rapid succession that contributes to creativity? Is there something inherent in the hand-eye coordination required to play videogames that is responsible for its relationship to creativity? Or is the cognitive stimulation produced by playing videogames responsible for this relationship? On the practical side, can videogame designers use this new knowledge to create videogames that increase creativity?

5. Conclusions

Results of our research indicate that there is a relationship between videogame playing and creativity in 12-year old children. No other type of information technology showed any relationships, regardless of how creativity was measured. There were no gender differences in creativity despite gender differences in videogame playing. Nor were there race difference in creativity or videogame playing although there were race and gender differences in the use of other types of information technologies. For example African American males were least likely to use cell phones whereas African American females used cell phone more than any other race × gender group. The next logical step for future research is to determine if the relationship between videogame playing and creativity is causal and, if so, in what direction. Learning that videogame playing contributes to creativity should motivate game designers to first identify the aspects of videogame activity are responsible for these effects. Once identified then videogames can be designed to optimize the development of creativity while retaining their entertainment values such that a new generation of edutaining video games will blur the distinction between education and entertainment,

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