Computers in Human Behavior Reports 1 (2020) 100015

Contents lists available at ScienceDirect

Computers in Human Behavior Reports

journal homepage: www.journals.elsevier.com/computers-in-human-behavior-reports

Positive associations between media multitasking and creativity

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ARTICLE INFO

Keywords:
Attentional control
Creativity
Media multitasking
Convergent thinking
Divergent thinking
Creative achievement

ABSTRACT

The ability to solve problems creatively is a vital educational outcome. Here we pursued the hypothesis that media multitasking (MM), which is becoming increasingly prevalent in modern learning contexts, may be positively associated with creative performance. One hundred and four participants completed a media multitasking questionnaire and three well-established creativity tasks: (1) Alternate Uses Task (AUT), (2) a modified version of the Remotes Associates Task (RAT) and, finally, (3) the Creative Achievement Questionnaire (CAQ). We adopted three common approaches in analysing the relationship between MM and creativity: (1) regression analyses with MM scores as a continuous predictor, (2) extreme-group analyses with high vs. low MM levels, as defined by one standard deviation above vs. below the mean, respectively, and (3) median-split analyses with high vs. low MM levels, as determined by scores above vs. below the median, respectively. Of the three approaches, the median-split analyses revealed that high-MM individuals performed better on the RAT task as well as scored higher in fluency and originality on the AUT task than did low-MM individuals. We further demonstrated that the positive relationship between MM and creativity was significantly enhanced by fluid intelligence and attenuated by attentional impulsivity.

1. Introduction

Creativity, generally defined as the ability to generate appropriately novel responses or solutions to problems (Sternberg & Lubart, 1999), is an invaluable cognitive skill across multiple domains in the modern world. Unsurprisingly, the cultivation and fostering of creative abilities has been the holy grail for many education systems worldwide (Grigorenko, 2019). In recent years, the educational landscape has witnessed the growing presence of portable, multi-functional digital devices—mobile phones, tablet, and laptop computers—that have brought about a sharp rise in media-multitasking behaviours in academic environments (Jacobsen & Forste, 2011; Ragan et al., 2014; Rideout et al., 2010; Tindell & Bohlander, 2012). The increased prevalence of media-multitasking has received much attention and concern from educators, owing to its associations with negative learning outcomes and academic performance (Junco, 2012; Loh & Kanai, 2016; May & Elder, 2018; Sana et al., 2013; Wammes et al., 2019).

At present, the relationship between media-multitasking and creativity performance, as well as the potential individual factors that moderate this relationship, remain virtually unexplored. These questions have important practical implications for modern-day education systems—how best learning environments may be positioned in the face of rapidly growing media-multitasking trends, in order to optimally foster creative development in learners.

1.1. A potential link between habitual media-multitasking and creative performance

The detrimental effects of media-multitasking in academic environments have often been attributed to increased distractibility and reduced attentional control that have been observed in individuals who engage in higher levels of habitual media-multitasking (HMMs) versus those who engage in lower levels of media-multitasking (LMMs) (Cain & Mitroff, 2011; Loh & Kanai, 2016; Ophir et al., 2009; Ralph et al., 2014; Uncapher & Wagner, 2018, but see Wiradhany et al., 2019). One prominent theory suggests that the negative attentional effects observed in HMMs could be linked with a breadth-biased attention style that could have emerged from the habitual consumption of multiple media forms in parallel or from rapid switching between the processing of different media types (Lin, 2009). Critically, though, this breadth-focused attention style might

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https://doi.org/10.1016/j.chbr.2020.100015
Received 5 January 2020; Received in revised form 30 March 2020; Accepted 2 May 2020
Available online xxxx

not necessarily result in impaired task performance. Lui and Wong (2012) demonstrated that HMMs actually performed better on a multi-sensory integration task involving the assimilation of non-attended information for target detection. This finding indicated that HMMs, by virtue of their non-selective, breadth-biased attentional processing styles, are able to integrate a wider range of—both attended and non-attended—environmental stimuli during information processing which may, in turn, boost task performance. In line with this finding, we pursued the hypothesis that HMMs might fare better than LMMs in creative performance, as their broadened attention scopes could enable them to better access relevant information during problem solving.

Indeed, prior research has revealed evidence for the positive effects of widened attentional scopes on creative performance (Kasof, 1997; Zabelina et al., 2015; Zmigrod et al., 2019). Mendelsohn and colleagues (Mendelsohn, 1976; Mendelsohn & Griswold, 1964, 1966; Mendelsohn & Lindholm, 1972) first suggested the idea that wider attentional breadths, in enabling access to a larger range of (both relevant and irrelevant) stimuli, increase the probability of forming links between disparate ideas or information, thereby facilitating creative performance. Consistent with this idea, Kasof (1997) found that individuals with higher scores on a trait measure of attentional breadth showed better creative performance on a poetry-writing task. Ansburg and Hill (2003) distinguished between the attentional tendencies of creative and analytic thinkers. Their results indicated that the attentional superiority in processing peripheral, incidental cues was linked to creative thinking. Crucially, the use of peripheral cues did not facilitate analytical problem solving. This characterization of broad attentional deployment accounts for a performance dip at tasks that required focused attention but suggests that creative performance may possibly be facilitated (Hennessey & Amabile, 2009). Taken together, the extant literature supports the postulation that HMMs, by virtue of their breadth-biased attention tendencies, could perform better on creativity tasks as compared to LMMs.

Currently, there are only two studies that have investigated the relationship between media-multitasking and creative performance, which reported mixed findings. The first study by Ophir et al. (2009) reported that HMMs versus LMMs (defined respectively as individuals with media-multitasking index scores that are one standard deviation above or below the sample mean) demonstrated no difference in performance on a creative task from the Torrance Tests of Creative Thinking (Torrance, 1974). Notably, the sample sizes were relatively small in this study—16 LMMs and 17 HMMs—and it was unclear whether the authors had used a composite score or examined the various sub-scales (e.g., flexibility, fluency, uniqueness) individually. In the second study by Duff et al. (2014), a positive relationship emerged between media-multitasking and creativity, as measured by Factor V of the Abridged Big Five-Dimensional Circumplex Model (Hofstee et al., 1992), a trait measure of the ability to make new connections and question norms.

To address these mixed results, the present investigation is poised to provide a more comprehensive exploration of the relationship between media-multitasking and creativity by (1) studying various facets of creative performance (e.g., convergent thinking, divergent thinking, and real-life creative achievement), (2) using different approaches to analyze media-multitasking index scores (e.g., regression analyses using media-multitasking index scores as a single continuous measure, and comparisons between high versus low media-multitasking groups based on median-splits or more extreme groupings, i.e., one standard deviation above versus below the sample mean, and (3) elucidating the potential individual factors that, if any, moderate the relationship between media-multitasking and creativity.

1.2. Facets of creative performance

The investigation of potential links between media-multitasking and creativity is not straightforward, as creativity is generally considered a multi-faceted phenomenon with various sub-divisions that involve distinct cognitive mechanisms (Dietrich, 2019). Thus, creativity could be differentially associated with and/or influenced by media-multitasking. In this research, we focused on three predominant facets of creativity that have been widely studied in the literature: Divergent thinking (Guilford, 1950, 1956, 1967), convergent thinking (Mednick, 1962), and real-life creative achievements (Carson et al., 2005). In particular, we discuss existing literature linking attentional control styles and performance on each of the three facets of creativity, and explicate our hypotheses on how habitual media-multitasking, which is associated with a breadth-biased attention control mode, might influence the various forms of creativity.

Divergent thinking. First conceived by J. P. Guilford (1950, 1956, 1967), divergent thinking is defined as the ability to generate multiple solutions to an open-ended problem. Divergent thinking is often measured via the Alternate Uses Task (AUT; Guilford, 1967) that involves subjects coming up with as many creative uses as possible for highly common items within a restricted amount of time. The AUT provides four component scores that measure distinct components of divergent thinking: (1) *Fluency*—total number of ideas generated, (2) *Originality*—uniqueness and novelty of the generated ideas, (3) *Elaboration*—amount of detail provided in each proposed use, and (4) *Flexibility*—the number of categories spanned by the proposed uses. Recent work has provided insights into the potential link between AUT performance and modes of attention control. For instance, Zabelina et al. (2016) recently demonstrated that selective, flexible attention, operationalised as the ability to attend to appropriate cues while switching between global- and local-oriented attentional levels, predicted better divergent thinking performance, as evidenced by a superior composite score of the AUT originality and fluency scores. More recently, Zabelina and Ganis (2018b), using an electroencephalogram study, replicated the positive relationship between the ability to flexibly switch between global- and local-oriented attentional focus and better divergent thinking performance, based on the same composite score. Critically, they reported that better divergent thinkers showed increased cognitive control-related neural responses (i.e., the N2 event-related potential) during attentional level switches, implicating that better divergent thinking performance was linked with a controlled mode of attentional flexibility. Further, Colzato and colleagues (2012) demonstrated that the engagement in *open monitoring meditation* (which evokes an unrestricted and flexible mode of attention whereby the individual is free to perceive and observe any thought or sensation in the environment without a central focus in mind), as opposed to *focused attention meditation* (which evokes a more focused attention control whereby the individual concentrates on a single thought), produces better flexibility, originality, and fluency scores.

Finally, a body of work by Beaty and colleagues (2016, 2018) has revealed that divergent thinking performance depends on, and can be predicted by, the interplay between three major brain networks: (1) the default mode network that is involved in the internal generation of ideas, (2) the executive network that is involved in the evaluation of ideas, and (3) the salience network that is involved in the shifting focus between the above two networks and detecting relevant stimuli. The findings are congruent with the perspective that optimal divergent thinking is supported by a coordination of flexible and controlled cognitive processes. Altogether, these studies suggest that divergent thinking—specifically in terms of flexibility, fluency, and originality but not elaboration scores—is enhanced by an attentional mode that is flexible (i.e., the scope or target of attention focus can be freely adjusted or switched) and selective (i.e., a certain degree of cognitive control is still involved to ensure the processing of goal-related information).

In the present study, we hypothesize that HMMs' breadth-biased attention control style, which gives less-restricted access to a wider range of information, would result in the generation of more ideas, and also more uncommon ideas, leading to higher fluency and originality scores on the AUT task, respectively:

H1. Higher media-multitasking levels will be associated with higher fluency scores on the Alternative Uses Task.

H2. Higher media-multitasking levels will be associated with higher originality scores on the Alternative Uses Task.

Considering that higher media-multitaskers engage more in the concurrent monitoring of multiple media forms and switching between them, we expected them to be better at switching and generating more categories of uses on the Alternative Uses Task:

H3. Higher media-multitasking levels will be associated with higher flexibility scores on the Alternative Uses Task.

Lastly, we predicted that since heavy media-multitaskers are habituated towards a breadth-, rather than depth-, biased mode of attention control, they would be less invested to provide details when coming up with potential uses of common items and, thus, have lower scores on the elaboration scale of the Alternative Uses Task, relative to light media-multitaskers:

H4. Higher media-multitasking levels will be associated with lower elaboration scores on the Alternative Uses Task.

Convergent thinking. Convergent thinking, in contrast to divergent thinking, represents a more constrained form of creativity that involves searching for a single solution to a well-defined problem in an analytic fashion (Guilford, 1967). The Remotes Associates Task (RAT; Mednick, 1962) is a well-known instrument for measuring convergent thinking ability. On the RAT, subjects are presented with three words, and have to produce a fourth word that forms a compound word with the given words. To perform well on this task, subjects would have to extend their attention beyond typical and frequent associations of the prime words, and into the less common associations, in order to find the correct solution word. Indeed, a recent study by Zmigrod et al. (2019) showed that the tendency to bind irrelevant and distractive information (i.e., broadened attention scope) is associated with better RAT performance. Corroborating this finding is an earlier study by the same authors (Zmigrod et al., 2015) which revealed that subjects who were more susceptible to global interferences whilst attending to local information performed better on the RAT task. Relatedly, heavy media-multitaskers were reportedly more prone to processing task-irrelevant information (Ophir et al., 2009) and attending to and integrating task-irrelevant inputs when performing a primary task (Lui & Wong, 2012). Accordingly, we hypothesized that heavy media-multitaskers would perform better on the RAT task as their broadened attention scopes would enable them to more quickly access the less typical associations of each question word and locate the solution word that is related to all three question words:

H5. Higher media-multitasking levels will be associated with better performance (i.e., more problems solved and higher solving rates) on the Remotes Associates Task.

Real-life creative achievement. The degree of real-life creative achievement, as typically measured by the creative achievement questionnaire (CAQ) (Carson et al., 2005), provides an ecologically useful operationalization of creativity. Briefly, the CAQ summarises an individual's attainments across 10 creativity domains: visual arts, music, dance, creative writing, architectural design, humour, theatre and film, culinary arts, inventions, and scientific inquiry. This measure enables an understanding of potential associations between media-multitasking and real-world creativity outcomes.

Prior work has generally associated higher real-world creative achievement with a diffuse or "leaky" form of attention that is characterized by the reduced filtering of irrelevant inputs (Zabelina et al., 2015, 2016). The researchers explained that a leaky attentional mode facilitates the detection of alternatives which is, in turn, beneficial for creative cognition. Along with the finding that high media-multitaskers have an increased tendency to process task-irrelevant information (Lui & Wong, 2012; Ophir et al., 2009), we expected a positive correlation between media-multitasking and real-life creative achievements:

H6. Higher levels of media-multitasking will be associated with higher scores on the Creative Achievement Questionnaire.

1.3. Potential factors influencing the associations between media-multitasking and creativity

Apart from determining the links between habitual media-multitasking and the various facets of creative performance, the present study seeks to reveal the individual factors that potentially moderate this relationship. In particular, we focus on a set of variables that has been suggested to moderate the attentional effects associated with media-multitasking, including age and sex (Baumgartner, van der Schuur, et al., 2017), fluid intelligence (Alzahabi et al., 2017), impulsivity (Shin et al., 2019; Uncapher et al., 2016) and the Big Five personality traits (Becker et al., 2013; Loh & Kanai, 2014). Studying the influence of these factors on the link between media-multitasking and creativity will provide insights into the possible ways to maximize (or mitigate) the potential positive or negative associations between media-multitasking on creative performance. Here we outline our hypotheses on how these factors might influence the link between media-multitasking and creative performance.

Age. In non-elderly populations (i.e., before the onset of age-related cognitive decline), increased age is generally associated with higher levels of self-control (Oliva et al., 2019) and attentional control (Cowan et al., 2006) that parallel the maturation of the frontal lobe (Tanaka et al., 2012). As such, we could expect that, with increased age, the attentional effects associated with higher levels of media-multitasking would be diminished. Congruent with this postulation, Baumgartner and colleagues (2017) revealed that media-multitasking led to long-term attentional detriments in younger but not older adolescents. Based on these findings, we hypothesize that the potential effect of media-multitasking on creativity performance will be *reduced* with increased age:

H7. The association between media-multitasking and creative performance will be reduced as age increases.

Sex. Biological sex has been demonstrated as a significant predictor of media-multitasking activity with female individuals engaging in higher levels of media-multitasking and experiencing stronger media-multitasking-associated attentional effects (Baumgartner, Lemmens, et al., 2017; Baumgartner, van der Schuur, et al., 2017; Duff et al., 2014; Pea et al., 2012; Rideout et al., 2010). As such, we hypothesized that the association between media-multitasking and creativity will be stronger in female than in male individuals:

H8. The effects of media-multitasking on creative performance will be increased in female than in male individuals.

Fluid Intelligence. Fluid intelligence, as typically measured by the Raven's Progressive Matrices (Raven et al., 1998), relates to the capacity for flexible reasoning, problem solving, and adapting to novel situations and is related to a variety of executive function tasks (Carpenter et al., 1990; Gray & Thompson, 2004). Importantly, fluid intelligence has been found to positively associate with the fluency component of divergent thinking, but unrelated to self-rated creative achievement scores (Batey et al., 2010). In relation to media-multitasking, Alzahabi et al. (2017) have demonstrated that higher fluid intelligence is related to increased active preparation for an upcoming task (as indicated by slower, but more accurate, performance) but this was negatively related to media-multitasking in the same study (i.e., higher media-multitasking is related to faster, but more inaccurate, performance). This indicated that fluid intelligence could potentially increase the tendencies of high media-multitaskers to engage in more deliberated (i.e., slower but more accurate) thinking, thereby improving cognitive performance. Accordingly, we predicted that higher fluid intelligence could strengthen the positive association between media-multitasking and creative performance:

H9. The association between media-multitasking and creative performance will be enhanced with higher fluid intelligence.

Impulsivity. Previous research has demonstrated strong positive links between trait impulsivity and media-multitasking tendencies (Minear et al., 2013; Sanbonmatsu et al., 2013; Shin et al., 2019; Uncapher et al., 2016). In particular, Shin et al. (2019) revealed that media-multitasking was positively associated with *attentional impulsivity*, but not with motor and non-planning impulsivity subscales on the Barratt Impulsivity Scale (Patton et al., 1995). Relatedly, they found that individuals with higher media-multitasking scores performed better on a dual-task paradigm, where a letter detection task and a tone detection task are presented in quick alternation and the participant had to switch attention quickly between the two tasks. This suggested that trait attentional impulsivity might potentially mediate or moderate the effects of media-multitasking on attentional switching, i.e., high media-multitaskers with higher attentional impulsivity might be better at switching attention between tasks. In this regard, we hypothesized that attentional impulsivity, in increasing the tendency of an individual to quickly switch attention between ideas, might potentially enhance the positive association between media-multitasking and creative performance:

H10. The effects of media-multitasking on creative performance will be enhanced with increased attentional impulsivity.

Big Five Personality Traits. To our knowledge, only two published studies (Becker et al., 2013; Loh & Kanai, 2014) have directly investigated associations between media-multitasking and the Big Five personality traits (i.e., extraversion, agreeableness, neuroticism, openness, and conscientiousness; McCrae, 1987). Of the five traits, only extraversion has been shown to positively correlate with media-multitasking (Becker et al., 2013; Loh & Kanai, 2014). Notably, extraversion has been shown to positively correlate with creative performance, along with openness to experience which emerged as a stronger predictor (Dahmen-Wassenberg et al., 2016). To these ends, we predicted that both extraversion and openness would positively enhance the association between media-multitasking and creativity:

H11. The association between media-multitasking and creative performance will be enhanced with increased extraversion and openness trait scores.

1.4. The present study

Our main goal was elucidating the potential links between media-multitasking and three main aspects of creativity, namely divergent thinking, convergent thinking, and real-life creativity. The media-multitasking questionnaire (Loh & Kanai, 2014) was adopted to assess the level of habitual media-multitasking with a number of commonly used media forms. Based on the questionnaire responses, a media-multitasking index (MMI) was computed, capturing the average number of other media consumed while engaging the 12 media types. In a recent review of existing literature about the cognitive effects of media-multitasking, Uncapher and Wagner (2018) noted the variety of approaches used to analyze media-multitasking scores in relation to cognitive performance, which could have caused the heterogeneous findings within the field. In the present work, we investigate the relationships between media-multitasking and divergent thinking (as measured by the four Alternate Uses Task subscales; Guilford, 1957), convergent thinking (as measured by the RAT task; Mednick, 1962), and real-life creativity achievement (as measured by the CAQ; Carson et al., 2005) via three commonly adopted approaches used to analyze MMI scores: (1) a regression analysis with MMI scores as a continuous predictor, (2) a comparison between high media-multitaskers (HMMs) and low media-multitaskers (LMMs) based on a median-split, and (3) an extreme-group comparison between HMMs and LMMs defined based on individuals with MMI scores of one standard deviation above or below the mean, respectively.

After determining the relationships between media-multitasking and the three aspects of creativity, we investigated, via independent multiple regression models, the potential moderation effects of age, sex, fluid intelligence (as measured by the Raven's standard progressive matrices (Raven et al., 1998), the Big Five personality traits (John & Srivastava, 1999), and impulsivity (as measured by the Barratt's Impulsivity Scale (Patton et al., 1995) on the relationship between media-multitasking and the three facets of creativity.

2. Method

2.1. Participants

One hundred and four undergraduate students [40 were male; mean age = 21.6 (SD = 1.7)] from the National University of Singapore (NUS) participated after providing written informed consent. This study was approved by the Institutional Review Board of the NUS. Participants received either course credits or a cash reimbursement of 10 Singapore Dollars after completing the entire study protocol. The main demographic, trait, and, task measures of the sample are summarized in Table 1.

2.2. Main measures

Media-multitasking Questionnaire (MMQ). We administered a modified version of Ophir et al.'s (2009) Media Multitasking Questionnaire by (Loh & Kanai, 2014), in measuring each participant's level of habitual media-multitasking activity. The two MMQ versions were virtually identical, except for the types of media included, i.e., the modified version included more contemporary media forms. In this version of the MMQ, participants reported: (1) the total number of hours per week they spent using 12 common media types (print media, television, computer-based video, music, voice calls using mobile or telephone, instant messaging, Short Messaging Service (SMS) messaging, Email, web surfing, gaming via computer, mobile phones or video gaming consoles, social networking sites, and other computer-based applications), and (2) how much they concurrently consumed each of other media as they were using each of the 12 media types. The amount of concurrent use was indicated on a scale of 1–4 (1 = "Never", 2 = "A little of the time", 3 = "Some of the time", and 4 = "Most of the time"). These responses were then recoded as follows: "Never" = 0, "A little of the time" = 0.33, "Some of the time" = 0.67, and "Most of the time" = 1. The recoded responses were subsequently summed for each primary medium to yield the mean number of media concurrently consumed whilst using a primary medium. The Media-Multitasking Index (MMI; Ophir et al., 2009) was then calculated for each subject, based on the following formula:

$$MMI = \sum_{i=1}^{11} \frac{m_i \times h_i}{h_{total}}$$

where m_i is the mean number of media concurrently used while using primary medium, i, h_i is the number of hours per week spent using the primary medium, i, and h_{total} is the total number of hours per week spent using all media forms. The questionnaire was administered in a computerized format via the Qualtrics survey platform.

Remotes Associates Task (RAT). The Remotes Associates Task (RAT), originally developed by Mednick (1962), was employed in the current study as a measure of convergent thinking ability. On this task, participants had to solve a series of 40 RAT problems (see Table 2) that each involved finding the convergent solution word (e.g., HONEY) that was associated with all three presented question words (e.g., DEW/COMB/BEE). The 40 RAT problems were selected from the list of 144 problems by Bowden and Jung-Beeman (2003), on the basis that these were deemed most appropriate for—perceived to be the most solvable and familiar to—the local undergraduate student population. In determining their suitability, we obtained, for each of the 144 problems, subjective ratings of solving difficulty and familiarity of the

Table 1
Summary of main experimental measures.

	Mean	SD	Range	Skewness	Kurtosis	Cronbach's α
n	104	–	–	–	–	–
Age	21.64	1.66	19–25	0.27	−0.91	–
Sex (% male)	38.46	–	–	–	–	–
MMI	3.22	1.61	0.64–7.43	0.56	−0.40	–
Ravens	33.15	2.48	25–36	−1.31	1.34	–
Impulsivity	59.66	8.22	43–82	0.42	−0.29	0.762
Big Five Inventory						
Openness	34.21	6.22	18–49	0.04	−0.45	0.797
Conscientiousness	28.27	5.45	13–40	−0.13	−0.58	0.796
Extraversion	23.30	6.57	8–39	0.32	−0.02	0.893
Agreeableness	32.30	4.72	22–42	−0.07	−0.89	0.711
Neuroticism	25.13	5.96	8–39	−0.31	0.17	0.861
Remotes Associates Task						
RAT_{RAW}	17.75	4.47	6–28	−0.13	−0.16	–
RAT_{RT}	8.60	1.36	5.60–12.16	0.17	−0.38	–
$RAT_{COMPOSITE}$	2.14	0.73	0.66–4.40	0.57	0.23	–
Alternate Uses Task						
Fluency	8.18	2.65	2.5–14.5	0.23	−0.62	0.797
Elaboration	3.69	2.58	0.0–12.0	0.94	0.84	0.733
Flexibility	4.86	1.15	1.5–7.0	−0.30	−0.13	0.611
Originality	2.93	2.22	0.00–9.5	0.72	−0.32	0.617
Creative Achievement						
CAQ	7.39	6.43	0–30	1.52	1.83	0.683

MMI = Media-Multitasking Index scores; RAT_{RAW} = number of correctly solved problems on the Remotes Associates Task; RAT_{RT} = mean time taken to solve each problem; $RAT_{COMPOSITE}$ = composite score computed by RAT_{RAW}/RAT_{RT}; CAQ = Creative Achievement Questionnaire scores.

question/answer words from an independent sample of ten local undergraduate students from our laboratorylaboratory at the National University of Singapore. Using these ratings, we selected 40 problems with the highest solvability and familiarity ratings.

In the present study, we implemented an augmented version of the RAT task, where we constrained the presentation duration of the question words for each problem and, also, the time allowed to solve each problem. The rationale was to encourage participants to solve each RAT problem via the "insight' route, i.e., the rapid assimilation of external information from the three presented words with minimal contemplation based on internal knowledge. The computerized version of the augmented RAT task was programmed and administered via Psychophysics Toolbox 3.0 (http://psychtoolbox.org/) running on Matlab R2015b (https://www.mathworks.com/). Participants first performed a short practice of five trials, before proceeding to the actual experiment comprising 40 RAT problem trials. Each problem trial began with the presentation of a black screen with three rectangular boxes for 1s. Subsequently, the three question words (e.g., DEW/COMB/BEE) were presented in the center of the three boxes for 10s. During question presentation, participants could hit the "Enter" key when the solution word (e.g., HONEY) came to mind. This would bring them to a response screen where they had to, within 10s, impute their answer and then hit the "Enter" key. The trial would be terminated if the participant had not pressed the "Enter" key within 10 s after question presentation. The next trial would commence after an inter-trial interval of 1s.

This task structure ensured that subjects had a maximum of 10s to conceive the solution word based on the presented question words, followed by another 10s to enter their answers. In other words, all subjects were restricted to a total of 20s to yield and type their solution word. Based on Bowden and Jung-Beeman (2003)'s normative data on the selected 40 problems, given a time limit of 30s, the average solving time for these problems was 9.11s and the average percentage of subjects solving these problems was 57.2% (see Table 2 for the norm solving rates of the 40 problems). As such, we expected the time limits we imposed to adequately motivate subjects to solve the RAT problems with minimal analytical thinking.

We computed two main measures from the task: (1) RAT_{RAW}, the total number of RAT problems correctly solved, and (2) $RAT_{COMPOSITE}$, computed by dividing RAT_{RAW} by the average time taken to solve each problem. The time taken for each correct problem was defined as the duration between the question onset and the second "Enter" press after imputing the correct word.

Alternate Uses Task (AUT). Guilford's Alternate Uses Task (AUT; Guilford, 1957) was used to assess divergent thinking. Participants listed as many possible uses as they could think of for two common household items—*pen* and *paper clip*—within a time limit of 3 min for each item. Participants were explicitly reminded to be as creative as possible in their responses. In the present study, the AUT was administered entirely on the Qualtrics survey platform. After an instructions screen, participants were presented with two successive task trials. In each trial, an image of the item (pen or paperclip) was shown, and the participant could enter as many uses as they could imagine for that item on the same screen. The trial automatically terminated after 3 min.

The coding of the AUT data was performed based on the scoring rubric by Kudrowitz and Dippo (2013). Under this framework, each response was subsumed under one of three distinct levels—*Keyword*, *Generalised function*, and *Treatment*. "Keywords" served as a first-level coding to condense the raw responses into more concise labels that capture their main idea, as a means to eliminate similar responses potentially written in different ways. "Generalised functions" provided a second-level coding that categorized the various "Keywords" based on their main function. "Treatment" provided a final superordinate level to categorise the various generalised functions based on how the object was physically manipulated to achieve these functions. As an example, a raw response to an alternative use of a pen "As chopsticks" will be labelled as "Chopsticks" at the *keyword* level, which simply summarises the proposed use. The same response will be coded "For consumption/cutlery" as its *generalised function* and, finally, "as a straight rod" as *treatment*, which describes how the pen is treated in performing its function as a chopstick.

The AUT data was coded by two research assistants. To ensure consistency in the coding, the two coders first jointly coded the first 10 participants' responses for both the pen and paperclip tasks, and resolved any disparity in views to reach full consensus on the coding criterion. Each coder then continued coding the remainder responses for either the paperclip or pen task independently.

As proposed in Kudrowitz and Dippo (2013), to compute the *Fluency* score, we summed the number of unique "Keywords" for each participant which corresponded to the total number of different uses proposed. *Flexibility* scores were computed by summing the total number of unique

Table 2
Remote associates task items and their normative solving rates.

Remote associate items	Solution	Solvability (% subjects)	Solving Time (s)	
			Mean	SD
DEW/COMB/BEE	HONEY	100	4.12	2.14
TOOTH/POTATO/HEART	SWEET	28	11.77	7.73
CRACKER/FLY/FIGHTER	FIRE	85	6.12	3.87
RIVER/NOTE/ACCOUNT	BANK	79	10.53	5.88
MAN/GLUE/STAR	SUPER	41	9.83	7.18
OPERA/HAND/DISH	SOAP	62	7.92	6.45
CREAM/SKATE/WATER	ICE	90	4.12	3.58
ROCKING/WHEEL/HIGH	CHAIR	87	5.84	5.36
FOOD/FORWARD/ BREAK	FAST	82	7.73	5.77
TYPE/GHOST/SCREEN	WRITER	54	9.37	7.08
AID/RUBBER/WAGON	BAND	69	6.51	4.62
STICK/MAKER/POINT	MATCH	21	12.19	8.15
LIGHT/BIRTHDAY/STICK	CANDLE	46	9.74	6.83
FORCE/LINE/MAIL	AIR	28	13.9	7.76
FISH/MINE/RUSH	GOLD	74	9.07	6.83
BREAK/BEAN/CAKE	COFFEE	33	14.04	6.90
SHOCK/SHAVE/TASTE	AFTER	31	10.84	7.93
NOTE/CHAIN/MASTER	KEY	26	12.68	5.30
LOSER/THROAT/SPOT	SORE	82	6.31	4.06
SLEEPING/BEAN/TRASH	BAG	82	6.80	6.36
MEASURE/WORM/ VIDEO	TAPE	87	8.36	5.24
SAFETY/CUSHION/ POINT	PIN	74	5.00	2.84
DREAM/BREAK/LIGHT	DAY	56	7.91	6.72
ILLNESS/BUS/ COMPUTER	TERMINAL	18	11.43	5.82
CROSS/RAIN/TIE	BOW	46	13.75	8.39
PRINT/BERRY/BIRD	BLUE	77	13.24	7.94
HOME/SEA/BED	SICK	10	5.83	2.77
HEALTH/TAKER/LESS	CARE	44	10.58	7.26
FIGHT/CONTROL/ MACHINE	GUN	28	13.92	6.28
WORM/SHELF/END	BOOK	85	6.76	6.25
KNIFE/LIGHT/PAL	PEN	62	9.19	7.14
CARPET/ALERT/INK	RED	59	11.02	8.14
CHAMBER/MASK/ NATURAL	GAS	44	5.27	4.90
FOUL/GROUND/MATE	PLAY	46	9.33	6.85
WAY/BOARD/SLEEP	WALK	64	11.45	8.44
RIGHT/CAT/CARBON	COPY	46	11.88	7.43
BLANK/LIST/MATE	CHECK	51	6.12	2.57
FLAKE/MOBILE/CONE	SNOW	79	8.68	7.02
NIGHT/WRIST/STOP	WATCH	97	6.27	5.83
DIVE/LIGHT/ROCKET	SKY	21	8.87	5.60

Normative values from Bowden and Jung-Beeman (2003), based on a solving time limit of 30s.

treatments, which corresponded to the number of different super-ordinate categories of uses given by a participant.

To compute the *Elaboration* score, each response was scored either 0, 1, or 2 based on how much descriptive detail was provided in the response. For instance, for the item "paper clip", such responses as "use as a tool" would be awarded 0 points for elaboration, whereas "use as a tool to reset calculator" would be awarded 1 point for describing how the pen could be used as a tool. Any response that mentioned two or more details about the use of a given pen, e.g., "repeatedly resetting my calculators before my exam", which included both the adjective "repeatedly" and an additional time condition "before my exam", would be awarded 2 points. The number of points were totalled to provide an Elaboration score for each participant.

To compute the *Originality* score, a given keyword was awarded 2 points if the same keyword was given by less than 1% of the participants, 1 point if the keyword was given by less than 5% of the participants, and 0 points otherwise. The total number of points was summed to give the originality score for each subject.

Fluency, flexibility, elaboration, and originality scores were first obtained separately for each task (pen vs. paperclip) and, then, averaged across the two tasks for each subject.

Creative Achievement Questionnaire (CAQ). The Creative Achievement Questionnaire (Carson et al., 2005) is a self-reported measure of an individual's attainments in 10 creativity domains: Visual arts, music, dance, creative writing, architectural design, humour, theatre and film, culinary arts, inventions, and scientific inquiry. The CAQ was administered entirely on the Qualtrics survey platform. For each of the domains, a list of eight sentences was presented, and participants were asked to check for the sentences that were applicable to them. Multiple selections per domain were allowed. For certain sentences with an asterisk next to them (e.g., "My compositions have been critiqued in a national publication"), participants were asked to indicate the number of times that the sentence applied to them. The CAQ was scored according to Carson et al.'s (2005) guidelines. Each checked item received the number of points represented by the question number adjacent to the checkmark. If an item was marked by an asterisk, the points for that item would be determined by multiplying the number of times the item had been achieved by the question's number. The total number of points within each domain was summed to yield the domain score, and the 10 domain scores were summed to determine the total CAQ score. In view of the skewed distribution of the CAQ scores, they were transformed by first adding one to each CAQ score, and subsequently taking the logarithm of that value.

Ravens. The abridged Raven's Standard Progressive Matrices (Raven et al., 1998) was used to assess general intelligence. The abridged version consists of 36 items from Sets B, C, and D, instead of the original 60 items from Sets A, B, C, D, and E. For each item, participants were required to select, from an array of eight options, the correct figure which fitted into the presented incomplete matrix. In determining each answer, participants must infer a rule that relates elements in the incomplete matrix, and judge which of the eight options adhered to the rule. Each correct answer earned 1 point, whereas each incorrect answer received 0 point. The task stimuli containing the incomplete matrices and the array of eight options was presented in paper format to the participants who then provided their responses via the Qualtrics survey platform.

Barrat Impulsiveness Scale (BIS). The Barrat Impulsiveness Scale (BIS; version 11; Patton et al., 1995) was used to assess trait impulsivity. On the original BIS, participants rated their frequency ("Rarely/Never"; "Occasionally"; "Often"; "Almost Always/Always") of experiencing the thoughts and behaviours expressed in the 30 statements. In the present study, three items were removed since they were irrelevant for the undergraduate student population: "I change jobs"; "I change residences"; "I spend or charge more than I earn". The BIS was administered entirely on Qualtrics survey platform. The total BIS score was computed as the sum of three sub-scales: attentional- (8 items), motor- (8 items), and non-planning impulsivity (11 items).

Big Five Inventory (BFI). The Big Five Inventory (BFI; John & Srivastava, 1999) was administered as a brief and reliable 44-item measure for the Big Five personality factors: extraversion (8 items), agreeableness (9 items), conscientiousness (9 items), neuroticism (8 items), and openness to experience (10 items). The subjects were presented with a list of the 44 statements, and indicated the extent of their (dis)agreement (1–Disagree strongly, 2–Disagree a little, 3–Neither agree nor disagree, 4–Agree a little, and 5–Agree strongly) with each statement. The BFI was administered entirely on Qualtrics survey platform.

2.3. Procedure

The study was conducted in a laboratory, with one subject per session that lasted an average of 60 min. At the start of each session, the participant was briefed about the study's protocol and the sequence of tasks. After which, informed consent and demographic details of the participant—gender, age, faculty of study and major, and year of study—were collected. All participants performed the tasks in the same order: (1) Alternative Uses Task, (2) trait questionnaires (i.e., media-multitasking questionnaire; Big Five Inventory; Creative Achievement Questionnaire; Barratt's Impulsivity Scale), (3) Ravens standard progressive matrices and, finally, (4) the computerized Remotes Associates Task (RAT). With the exception of RAT, which was presented via the Psychophysics Toolbox running on Matlab, all tasks were administered via the Qualtrics survey platform. For tasks on the Qualtrics survey platform, all instructions were self-contained—automated—within the platform. As such, the participant cycled through the tasks at his/her own pace until the end of the Ravens task. At this point, the experimenter was informed, who subsequently set up the RAT task for the participant. For the RAT task, participants performed a practice trial before undergoing the actual trial. The participants' performance was monitored by the experimenter during the practice trial. Feedback and clarifications were provided to ensure that the participants performed the practice trial correctly before embarking on the actual trial. At the end of the entire study, the participant was debriefed about the aims of the study.

2.4. Statistical analyses

The main goals of our statistical analyses were (1) to elucidate the potential relationships between habitual media-multitasking and the various creativity measures, and (2) to reveal the individual factors that moderate these relationships.

To achieve the first goal, we performed three sets of analyses: Firstly, using media-multitasking index (MMI) scores as a continuous predictor, we ran independent regression analyses on the measures of performance on the Remotes Associates Task (RAT), the Alternative Uses Task (AUT), and the Creative Achievement Questionnaire (CAQ) via the *lm* function (*stats* package, version 3.6.1, RStudio). Secondly, using a median-split, we grouped participants into heavy (HMMs) or light media-multitaskers (LMMs) and performed two-samples t-tests to examine how the two groups differed across the various creative measures via the *t.test* function (*stats* package, version 3.6.1) running in RStudio (Rstudio Team, 2015). Lastly, we performed extreme-group analyses where we grouped subjects with MMI scores of a standard deviation above and below the sample mean as HMMs and LMMs, respectively, and performed t-tests to determine group differences in the various creative measures.

Based on the first analysis, significant associations of media-multitasking with the raw and composite RAT scores, as well as the fluency and originality subscales of the AUT, were observed only when MMI scores were analysed via the median-split approach. Thus, in our second analysis, which aimed to determine the individual factors that significantly moderated the relationship between media-multitasking and creative performance, we performed separate regression analyses (*lm* function, *stats* package, version 3.6.1, RStudio) to investigate the interaction effects between MMI group (based on a median-split) and each individual factor (age, sex, fluid intelligence, openness, extraversion, neuroticism, agreeableness, conscientiousness, attentional impulsivity, motor impulsivity, or non-planning impulsivity), on each of the four creative measures that was significantly related to media-multitasking (i.e., RAT raw scores, RAT composite scores, fluency, and originality). Each regression model included one of the creative measures as the dependent variable, along with MMI group, one of the individual factors, and the interaction between them as predictor variables. Age, fluid intelligence, openness, extraversion, neuroticism, agreeableness, conscientiousness, attentional impulsivity, motor impulsivity, or non-planning impulsivity were mean-centered before being entered into the regression models.

3. Results

3.1. Summary of experimental measures

Table 1 provides a summary of the experimental measures obtained from the 104 participants. The mean Media-Multitasking Index (MMI) score in the present sample was 3.22 (SD = 1.61, range = 0.64–7.43). This was consistent with the mean MMIs obtained from the National University of Singapore's undergraduate population in our previous investigations, e.g., 3.65 in (Loh et al., 2016); 3.15 in (Yap & Lim, 2013).

On the Remotes Associates Task (RAT), participants solved an average of 17.8 (SD = 4.5, range = 6–28) out of 40 problems. This suggested that our time-constrained version of the RAT task was relatively challenging for the participants. However, a floor effect on the task was unlikely since both distributions of the raw number of problems solved (RAT_{RAW}) and the number of problems solved weighted by response times ($RAT_{COMPOSITE}$) were minimally skewed (skewness and kurtosis values = -0.13 and -0.16 for RAT_{RAW}; 0.57 and 0.23 for $RAT_{COMPOSITE}$, respectively). The average time taken to solve each problem in our sample was 8.6s (SD = 1.36, range = 5.6–12.2s). Based on the normative data from Bowden & Jung-Beeman (2003), the mean solving time for the same 40 problems (with a 30s limit) was 9.11s. The reduced solving times observed in our study could likely be due to the fact that we had selected items that had been rated to be the most familiar and solvable by the local population and, also, the fact that we had explicitly constrained the solving time of the items on the task (10s of question presentation and 10s to enter the response).

On the Alternate Uses Task (AUT), participants generated an average of 8.2 (SD = 2.7, range = 2.5–14.5s) unique keywords (fluency) and 4.9 (SD = 1.2, range = 1.5–7.0s) unique treatments/categories of uses (flexibility). The mean elaboration and originality scores were 3.7 (SD = 2.6, range = 0–12) and 2.9 (SD = 2.2, range = 0–9.5), respectively, while the mean Creative Achievement Questionnaire (CAQ) score was 7.4 (SD = 6.4, range = 0–30). In view of the skewed distribution of CAQ scores, the log-transformation of the CAQ values plus one (to avoid taking the logarithm of 0 scores) were used for the subsequent statistical analyses.

3.2. Relationships between media-multitasking and creativity

The potential links between media-multitasking and creative performance were investigated via three distinct analyses that used three common approaches to analyze media-multitasking index scores (MMI): (1) Regression analyses on the three creative measures using MMI scores as a continuous predictor, (2) Group comparisons on the creative measures with high (HMM) and low (LMM) media-multitasking groups defined based on a median-split of MMI scores (median = 2.90), and (3) Extreme group comparisons on creative measures based on HMM and LMM groups defined by individuals having MMI scores of a standard deviation above (i.e., MMI score > 4.83) or below the sample mean (i.e., MMI score < 1.61), respectively. The above analyses are intended to provide a comprehensive understanding of relationships between MMI and the various creative measures and, crucially, insights about the influence of different analyses approaches on the results.

Regression analyses. Media-multitasking index (MMI) scores were used as a continuous variable to predict, via separate simple regression models: (1) RAT_{RAW}, (2) $RAT_{COMPOSITE}$, (3) fluency, (4) originality, (5) flexibility, (6) originality, and (7) log-transformed CAQ scores. The distribution of the MMI scores is depicted in Fig. 1 (top panel) via a raincloud plot (Allen, 2019). Based on the plot, the distribution of MMI scores appear to be slightly right-skewed (skewness and kurtosis = 0.56 and -0.4, respectively). Results from the simple regression analyses indicated that MMI scores do notsignificantly predict RAT_{RAW}, $RAT_{COMPOSITE}$, fluency, originality, flexibility, originality and log-transformed CAQ scores (p > 0.184 in all models, df = 102).

Median-split group comparisons. To compare the relationships between heavy (HMM) versus light (LMM) habitual media-multitasking and creativity performance, we grouped participants into LMMs and HMMs based on a median-split on their MMI scores (median MMI score = 2.90, n = 52 in both groups). The distribution of MMI scores for the two groups are shown in Fig. 1 (middle panel). A summary of the main experimental measures in the two groups appears in Table 3. The average MMI scores for LMMs and HMMs were 1.90 (SD = 0.6) and 4.54 (SD = 1.1), respectively. As expected, the group difference in MMI scores was

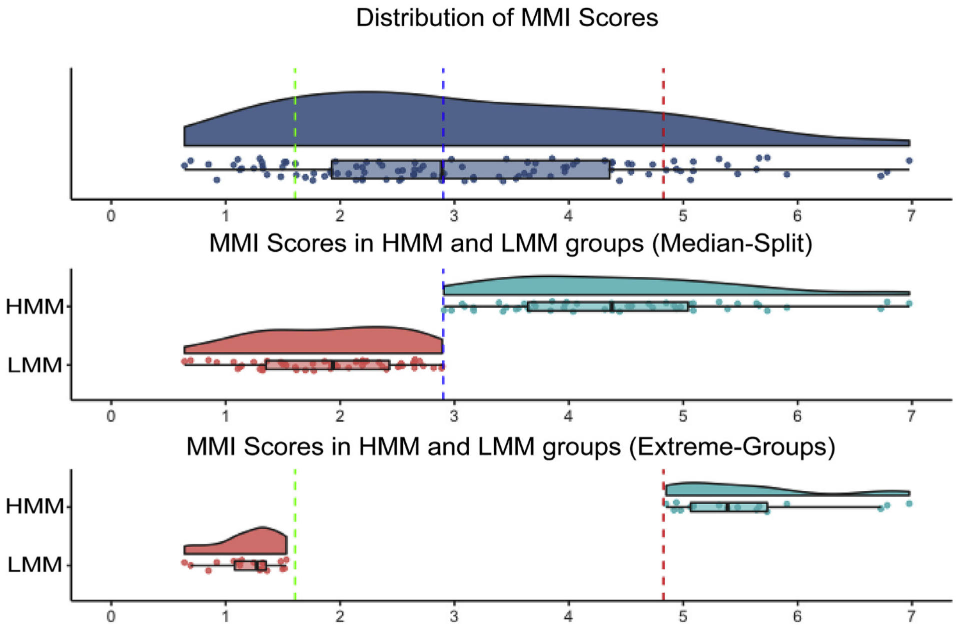

Fig. 1. Distribution of media-multitasking scores. Raincloud plots (Allen, 2019) showing the distribution of media-multitasking index (MMI) scores across the entire sample (Top panel), the distributions of MMI scores in high media-multitasking (HMM, indicated in blue) and low media-multitasking (LMM, indicated in red) groups determined by median-split (Middle panel), and the distributions of HMM (blue) and LMM (red) groups determined by individuals having MMI scores of one standard deviation above or below the mean, respectively. The dark blue dotted line indicates the median MMI value (2.90). The green and red dotted lines indicate the MMI value corresponding to one standard deviation below (1.61) and above the mean (4.83), respectively. Boxplots indicate the median value of the distribution (dark middle line), the first and third quartiles (left and right ends of the rectangle), and the values corresponding to 1.5 times the inter-quartile range (two ends of the whiskers). Each dot represents a single subject's MMI score.

Table 3
Comparisons between median-split LMM and HMM groups.

	LMM		HMM		*t*	*p*	*Cohen's d*	*1 – β*
	Mean	*SD*	Mean	*SD*				
n	52	–	52	–	–	–	–	–
Age	21.77	1.74	21.52	1.58	0.766	0.445	0.150	0.118
Male (%)	42.3	–	34.6	–	–	–	–	
MMI	**1.90**	**0.62**	**4.54**	**1.14**	**14.638**	**< 0.001**	**2.871**	**<0.999**
Ravens	33.33	2.26	32.98	2.70	0.709	0.480	0.139	0.108
Barratt Impulsivity Scale								
Attentional	17.48	4.01	18.10	2.86	0.901	0.370	0.177	0.145
Motor	17.02	3.78	17.35	3.35	0.466	0.642	0.091	0.075
Non-planning	24.75	3.93	24.63	3.78	0.153	0.879	0.030	0.053
Big Five Inventory								
Openness	33.83	5.89	34.60	6.57	0.629	0.531	0.123	0.096
Conscientiousness	28.85	5.80	27.69	5.07	1.081	0.282	0.212	0.188
Extraversion	22.77	6.60	23.83	6.56	0.820	0.414	0.161	0.128
Agreeableness	32.37	4.82	32.23	4.67	0.145	0.885	0.028	0.052
Neuroticism	24.98	6.02	25.29	5.96	0.262	0.794	0.051	0.058
Convergent Thinking								
RAT_{RAW}	**16.87**	**5.03**	**18.63**	**3.66**	**2.051**	**0.043**	**0.402**	**0.529**
RAT_{RT}	8.79	1.35	8.42	1.36	1.376	0.172	0.270	0.276
$RAT_{COMPOSITE}$	**1.98**	**0.73**	**2.30**	**0.71**	**2.220**	**0.029**	**0.434**	**0.593**
Divergent Thinking								
Fluency	**7.56**	**1.98**	**8.81**	**3.07**	**2.466**	**0.015**	**0.484**	**0.685**
Elaboration	4.08	2.69	3.31	2.42	1.532	0.129	0.300	0.329
Flexibility	4.81	1.04	4.91	1.26	0.467	0.641	0.092	0.075
Originality	**2.44**	**1.87**	**3.41**	**2.45**	**2.272**	**0.025**	**0.446**	**0.614**
Creative Achievement								
CAQ[a]	7.54	6.47	7.25	6.45	0.142	0.887	0.028	0.052

df = 102 for all t-tests performed; High (HMM) and low (LMM) media-multitasking groups were divided based on a median-split on media-multitasking index (MMI) scores; RAT_{RAW} = number of correctly solved problems on the Remotes Associates Task; RAT_{RT} = mean time taken to solve each problem; $RAT_{COMPOSITE}$ = composite score computed by RAT_{RAW}/RAT_{RT}; Statistical power ($1 - \beta$) is computed based on $\alpha = 0.05$; [a]Mean and standard deviation values based on raw Creative Achievement Questionnaire (CAQ) scores; statistical test values were based on log-transformed (1+CAQ); Measures which significantly differ between groups ($p < 0.05$) are indicated in bold.

significant ($t = 14.6$, $df = 102$, $p < 0.0001$, Cohen's d = 2.87). For convergent thinking performance, higher media-multitaskers performed significantly better on the speeded RAT task: Relative to LMMs, HMMs had higher RAT_{RAW} ($t = 2.05$, $df = 102$, $p = 0.043$, Cohen's d = 0.402) and $RAT_{COMPOSITE}$ ($t = 2.22$, $df = 102$, $p = 0.029$, Cohen's d = 0.435) scores. In terms of divergent thinking, HMMs had significantly higher scores for fluency ($t = 2.47$, $df = 102$, $p = 0.015$, Cohen's d = 0.484) and originality ($t = 2.27$, $df = 102$, $p = 0.025$, Cohen's d = 0.446). No significant differences were observed for flexibility and elaboration (*ps* > 0.129), however. Creative achievement scores did not significantly differ between groups ($p = 0.887$). Notably, LMM and HMM groups did not differ in terms of age, Raven's score, attentional, motor and non-planning impulsivity, and the Big Five traits (all *ps* > 0.282).

Extreme-group comparisons. The same group comparison analyses as above were repeated with extreme HMM and LMM groups created based on individuals with media-multitasking index scores one standard deviation above and below the mean, respectively. This grouping resulted in 19 individuals in the extreme HMM group and 18 in the extreme LMM group. The distributions of the two groups are displayed in Fig. 1 (Middle panel). As expected, the group difference in MMI scores was significant, mean (SD) of extreme HMM group = 5.8 (0.9), mean (SD) of extreme LMM group = 1.2 (0.3), $t = 21.6$, $df = 35$, $p < 0.0001$, Cohen's d = 7.09. Individuals in the extreme HMM group showed significantly lower conscientiousness scores, mean (SD) of extreme HMM group = 26.7 (3.7), mean (SD) of extreme LMM group = 29.8 (4.7), $t = 2.20$, $df = 35$, $p = 0.035$, Cohen's d = 0.72 but no significant differences in the other personality traits, age, sex, fluid intelligence, attentional, motor, and non-planning impulsivity measures. Importantly, the extreme groups showed no difference across all creativity measures (all $ps > 0.191$).

Summing up the above results, significant associations between media-multitasking and creativity were observed only with the median-split approach, but not with extreme-group analysis or regression analyses with media-multitasking scores as a continuous predictor. This observation echoes recent sentiments (e.g., Uncapher & Wagner, 2018) that the highly-mixed findings about the cognitive effects of media-multitasking in the field are related to the fact that different studies had adopted different approaches to analyze media-multitasking scores. From our median-split analyses, we found significant positive associations of high versus low media-multitasking with performance on the RAT task, and fluency and originality scores on the AUT task. This result provides support for our hypotheses that increased media-multitasking is linked to better RAT performance (H5), fluency (H1), and originality (H2). However, contrary to what we hypothesized, no significant associations emerged for elaboration (H4), flexibility (H3), and CAQ scores (H6) across all three analytical methods. These results are discussed further in the Discussion section.

3.3. Potential moderators of the relationships between media-multitasking and creativity

The second goal of the present research is to determine the potential individual factors that moderate the associations between media-multitasking and creative performance. Here, we pursued the significant associations of high versus low media-multitasking levels with creativity that we observed from our previous analyses. Specifically, we investigated, via separate regression analyses, whether each of the following factors: age, sex, fluid intelligence, openness, conscientiousness, extraversion, agreeableness, neuroticism, attentional impulsivity, motor impulsivity, and non-planning impulsivity, significantly moderated the effects we observed with MMI group (based on median-split) on each of the following creative measures: Raw and composite RAT scores, fluency, and originality. The summaries of the main statistics associated with all the above regression analyses appear in Tables 4–6.

No significant interaction effects of Age, Sex and the Big Five Traits. Contrary to our hypotheses H7, H8, and H11, there were no significant interaction effects of MMI group with age, sex, openness and extraversion (as well as the other Big Five personality traits) across all four investigated creative measures ($p > 0.05$; see Tables 4 and 5). This indicated that age, sex, and the Big Five personality traits did not significantly influence the association of habitual media-multitasking with RAT performance (raw and composite RAT scores), and AUT performance (fluency and originality).

Significant interaction effect of Fluid Intelligence. We observed a significant interaction effect of fluid intelligence (with media-multitasking group) on fluency scores ($MMI_{GROUP} \times$ Fluency interaction: $\beta = 0.38$, $p = 0.043$; Table 4), but not on originality scores and the two metrics of RAT performance ($ps > 0.05$; Table 4). To understand the interaction effect, we plotted the predicted fluency values associated with increasing levels of fluid intelligence (i.e., one standard deviation below the mean value, the mean value, and one standard deviation above the mean value) in high and low media-multitasking groups (Fig. 2, left panel). It can be observed that the increase in fluency scores from LMM to HMM groups was enhanced with higher fluid intelligence levels. This result was congruent with our prediction (H9) that higher fluid intelligence will enhance the association of media-multitasking with creative performance.

Significant interaction effect of Attentional impulsivity. We observed a significant interaction effect of attentional impulsivity (with media-multitasking group) on fluency scores ($MMI_{GROUP} \times$ Fluency interaction: β = -0.62, p = 0.002; Table 6), and originality scores ($MMI_{GROUP} \times$ Originality interaction: β = -0.40, p = 0.048; Table 6), but not both metrics of RAT performance ($ps > 0.05$; Table 6). Non-planning and motor impulsivity scores did not significantly moderate the effect of media-multitasking across all four creative measures (p of interaction terms > 0.05; Table 6). To understand the significant interaction effects, we plotted the predicted fluency values (Fig. 2, middle panel) and originality values (Fig. 2, right panel)

Table 4
Regression analyses on the effects of age, sex and fluid intelligence on the relationships between media-multitasking and creativity.

Regression Models	Raw RAT Scores				Composite RAT Scores				Fluency				Originality			
	B	SE	β	p	B	SE	β	p	B	SE	β	p	B	SE	β	p
Age																
MMI_{GROUP}	1.90	0.85	0.42	**0.028**	0.34	0.13	0.47	**0.012**	1.26	0.51	0.48	**0.015**	1.01	0.43	0.46	**0.020**
Age	0.21	0.35	0.08	0.550	0.05	0.05	0.11	0.378	0.00	0.21	0.00	0.995	0.15	0.18	0.11	0.394
MMI_{GROUP} * Age	0.60	0.52	0.22	0.249	0.15	0.08	0.35	0.066	0.11	0.31	0.07	0.714	0.03	0.26	0.02	0.922
R^2	0.084				0.146				0.059				0.063			
F	3.04			**0.033**	5.70			**0.001**	2.08			0.108	2.23			0.089
Sex																
MMI_{GROUP}	1.95	1.40	0.44	0.165	0.51	0.22	0.69	**0.027**	0.57	0.82	0.22	0.488	0.69	0.70	0.31	0.324
Sex	−1.18	1.23	−0.26	0.342	−0.14	0.20	−0.19	0.480	−0.25	0.73	−0.10	0.727	−0.30	0.62	−0.13	0.631
MMI_{GROUP} * Sex	−0.14	1.78	−0.03	0.935	−0.28	0.29	−0.38	0.330	1.07	1.05	0.40	0.313	0.46	0.89	0.21	0.605
R^2	0.058				0.089				0.068				0.051			
F	2.06			0.110	3.24			**0.025**	2.44			0.069	1.79			0.154
Fluid Intelligence																
MMI_{GROUP}	1.89	0.85	0.42	**0.028**	0.33	0.14	0.46	**0.017**	1.34	0.48	0.50	**0.007**	1.04	0.42	0.47	**0.014**
Intelligence	0.62	0.27	0.35	**0.022**	0.11	0.04	0.36	**0.016**	0.04	0.15	0.04	0.782	0.14	0.13	0.15	0.303
MMI_{GROUP} * Int.	−0.55	0.35	−0.30	0.121	−0.08	0.06	−0.26	0.175	0.41	0.20	0.38	**0.043**	0.15	0.17	0.17	0.375
R^2	0.090				0.106				0.161				0.118			
F	3.28			**0.024**	3.95			**0.010**	6.39			**0.001**	4.47			**0.006**

RAT_{RAW} = number of correctly solved problems on the Remotes Associates Task (RAT); $RAT_{COMPOSITE}$ = composite score computed by RAT_{RAW} weighted by the mean problem solving time; MMI_{GROUP} = categorical variable coding for high (HMM) or low media-multitaskers (LMM) based on a median-split on their media-multitasking index (MMI) scores; Reference group for MMI_{GROUP} is LMM; Sex = categorical variable coding for males (reference group) and females; B = unstandardized coefficient of the predictor; SE = standard error of B; β = standardized coefficient of the predictor; $n = 104$ for all models.

Table 5
Regression analyses on the effects of the Big Five personality traits on the relationships between media-multitasking and creativity.

Regression Models	Raw RAT Scores				Composite RAT Scores				Fluency				Originality			
	B	*SE*	*β*	*p*	*B*	*SE*	*β*	*p*	*B*	*SE*	*β*	*p*	*B*	*SE*	*β*	*p*
Openness (O)																
MMI Group	1.64	0.84	0.37	0.054	0.29	0.14	0.39	**0.038**	1.17	0.50	0.44	**0.020**	0.91	0.42	0.41	**0.033**
O	0.25	0.10	0.35	**0.015**	0.03	0.02	0.26	0.067	0.10	0.06	0.23	0.113	0.06	0.05	0.17	0.223
MMI Group * O	−0.18	0.14	−0.25	0.190	0.00	0.02	0.00	0.982	0.01	0.08	0.02	0.899	0.04	0.07	0.11	0.558
R^2	0.101				0.115				0.113				0.107			
F	3.73			**0.013**	4.34			**0.006**	4.26			**0.007**	3.98			**0.010**
Conscientiousness (C)																
MMI Group	1.67	0.86	0.37	0.057	0.31	0.14	0.42	**0.032**	1.33	0.51	0.50	**0.010**	1.04	0.42	0.47	**0.016**
C	−0.18	0.11	−0.22	0.091	−0.02	0.02	−0.17	0.200	0.01	0.06	0.03	0.833	−0.01	0.05	−0.02	0.853
MMI Group * C	0.18	0.16	0.22	0.262	0.04	0.03	0.28	0.149	0.10	0.09	0.21	0.272	0.14	0.08	0.35	0.073
R^2	0.067				0.067				0.082				0.094			
F	2.39			0.074	2.41			0.071	2.97			**0.036**	3.47			**0.019**
Extraversion (E)																
MMI Group	1.79	0.87	0.40	**0.043**	0.31	0.14	0.42	**0.031**	1.23	0.51	0.46	**0.019**	0.96	0.43	0.43	**0.028**
E	−0.04	0.09	−0.06	0.659	−0.01	0.02	−0.10	0.481	0.01	0.06	0.03	0.806	0.04	0.05	0.11	0.416
MMI Group * E	0.05	0.13	0.07	0.723	0.03	0.02	0.23	0.233	0.02	0.08	0.04	0.844	−0.06	0.07	−0.18	0.358
R^2	0.042				0.060				0.059				0.057			
F	1.45			0.234	2.12			0.102	2.11			0.104	2.00			0.118
Agreeableness (A)																
MMI Group	1.76	0.86	0.39	**0.044**	0.31	0.14	0.43	**0.031**	1.25	0.51	0.47	**0.016**	0.97	0.43	0.44	**0.026**
A	0.02	0.13	0.03	0.846	−0.00	0.02	−0.00	0.978	0.02	0.08	0.03	0.829	0.02	0.06	0.04	0.745
MMI Group * A	−0.20	0.18	−0.21	0.279	−0.01	0.03	−0.06	0.774	−0.09	0.11	−0.16	0.398	−0.08	0.09	−0.17	0.383
R^2	0.057				0.048				0.066				0.057			
F	2.00			0.119	1.67			0.179	2.34			0.078	2.01			0.118
Neuroticism (N)																
MMI Group	1.80	0.86	0.40	**0.040**	0.32	0.14	0.43	**0.027**	1.28	0.50	0.48	**0.012**	0.98	0.43	0.44	**0.024**
N	−0.09	0.10	−0.12	0.368	−0.01	0.02	−0.06	0.646	−0.07	0.06	−0.16	0.225	−0.03	0.05	−0.09	0.512
MMI Group * N	−0.02	0.15	−0.02	0.909	−0.02	0.02	−0.13	0.517	−0.03	0.08	−0.06	0.761	−0.01	0.07	−0.01	0.945
R^2	0.058				0.065				0.094				0.058			
F	2.05			0.112	2.34			0.078	3.46			**0.019**	2.03			0.114

RAT_{RAW} = number of correctly solved problems on the Remotes Associates Task (RAT); $RAT_{COMPOSITE}$ = composite score computed by RAT_{RAW} weighted by the mean problem solving time; MMI_{GROUP} = categorical variable coding for high (HMM) or low media-multitaskers (LMM; Reference group) based on a median-split on their media-multitasking index (MMI) scores; B = unstandardized coefficient of the predictor; SE = standard error of B; β = standardized coefficient of the predictor; $n = 104$ for all models.

Table 6
Regression analyses on the effects of attentional, motor and non-planning impulsivity on the relationships between media-multitasking and creativity.

Regression Models	Raw RAT Scores				Composite RAT Scores				Fluency				Originality			
	B	*SE*	*β*	*p*	*B*	*SE*	*β*	*p*	*B*	*SE*	*β*	*p*	*B*	*SE*	*β*	*p*
Attentional Impulsivity																
MMI Group	1.89	0.86	0.42	**0.031**	0.34	0.14	0.46	**0.016**	1.35	0.49	0.51	**0.007**	1.04	0.42	0.47	**0.015**
Att-Imp	−0.07	0.15	−0.05	0.647	−0.00	0.02	−0.02	0.843	0.08	0.09	0.10	0.371	0.01	0.07	0.02	0.846
MMI Group * Att-Imp	−0.26	0.26	−0.20	0.326	−0.08	0.04	−0.37	0.071	−0.47	0.15	−0.62	**0.002**	−0.26	0.13	−0.40	**0.048**
R^2	0.064				0.098				0.153				0.097			
F	2.27			0.085	3.61			**0.016**	6.03			**0.001**	3.60			**0.016**
Motor Impulsivity																
MMI Group	1.77	0.87	0.40	**0.044**	0.31	0.14	0.42	**0.031**	1.24	0.51	0.47	**0.017**	0.98	0.43	0.44	**0.024**
Motor-Imp	−0.11	0.16	−0.09	0.489	−0.02	0.03	−0.08	0.534	0.06	0.10	0.09	0.506	0.05	0.08	0.09	0.504
MMI Group * Motor-Imp	0.25	0.25	0.20	0.315	0.05	0.04	0.24	0.225	−0.09	0.15	−0.12	0.530	−0.16	0.12	−0.25	0.203
R^2	0.049				0.061				0.061				0.064			
F	1.73			0.166	2.15			0.099	2.17			0.097	2.28			0.084
Non-planning Impulsivity																
MMI Group	1.78	0.87	0.40	**0.043**	0.31	0.14	0.43	**0.030**	1.25	0.51	0.47	**0.017**	0.96	0.42	0.43	**0.025**
NP-Imp	0.04	0.16	0.04	0.789	−0.00	0.03	−0.01	0.957	−0.03	0.09	−0.04	0.756	−0.02	0.08	−0.03	0.840
MMI Group * NP-Imp	0.07	0.23	0.06	0.758	0.02	0.04	0.09	0.660	0.01	0.13	0.02	0.931	−0.15	0.11	−0.25	0.194
R^2	0.045				0.049				0.057				0.086			
F	1.56			0.203	1.72			0.169	2.03			0.114	3.12			**0.029**

RAT_{RAW} = number of correctly solved problems on the Remotes Associates Task (RAT); $RAT_{COMPOSITE}$ = composite score computed by RAT_{RAW} weighted by the mean problem solving time; MMI_{GROUP} = categorical variable coding for high (HMM) or low media-multitaskers (LMM; Reference group) based on a median-split on their media-multitasking index (MMI) scores; B = unstandardized coefficient of the predictor; SE = standard error of B; β = standardized coefficient of the predictor; $n = 104$ for all models.

associated with increasing levels of attentional impulsivity (i.e., one standard deviation below the mean value, the mean value, and one standard deviation above the mean value) in high and low media-multitasking groups. It can be observed that higher attentional impulsivity resulted in *lower* increases in both fluency and originality scores from low to high media-multitasking levels. This result contradicted our hypothesis (H10) that higher attentional impulsivity will enhance the association of media-multitasking with creativity.

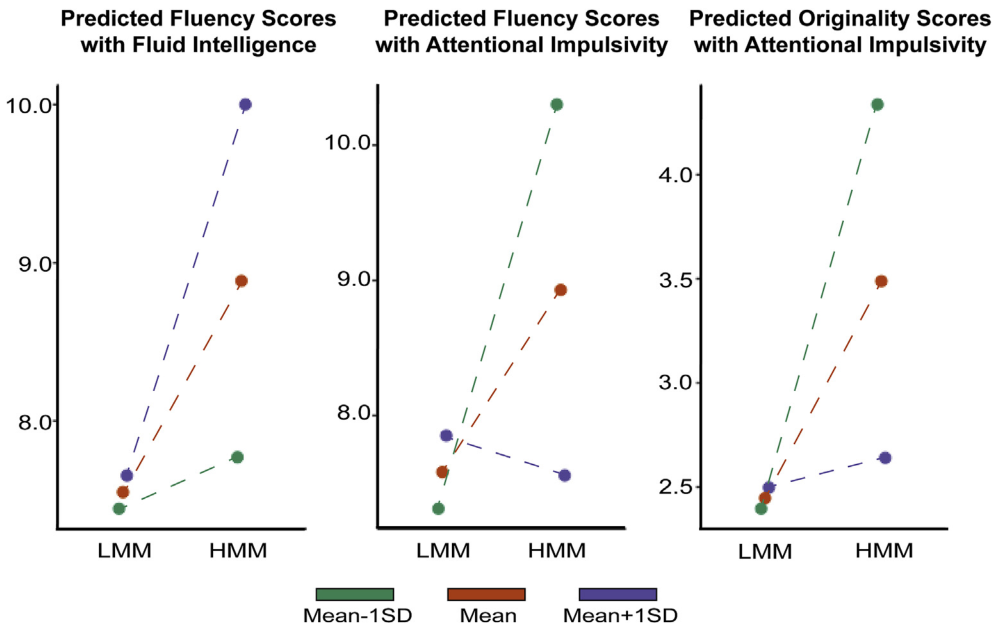

Fig. 2. Plots of significant interaction effects. (Left) Predicted values of Fluency scores at three levels of mean-centered Fluid Intelligence values: (1) the mean (orange), (2) one standard deviation above the mean (purple), and (3) one standard deviation below the mean (green), for high (HMM) and low media-multitasking (LMM) groups defined based on a median-split. (Middle) Predicted values of Fluency scores at three levels of mean-centered Attentional Impulsivity values: (1) the mean (orange), (2) one standard deviation above the mean (purple), and (3) one standard deviation below the mean (green), for high (HMM) and low media-multitasking (LMM) groups defined based on a median-split. (Right) Predicted values of Originality scores at three levels of mean-centered Attentional Impulsivity values: (1) the mean (orange), (2) one standard deviation above the mean (purple), and (3) one standard deviation below the mean (green), for high (HMM) and low media-multitasking (LMM) groups defined based on a median-split.

4. Discussion

The present study pioneered an investigation of the relationship between habitual media-multitasking and three key aspects of creativity performance—convergent thinking, divergent thinking, and real-life creativity achievement, as well as the potential individual factors that moderate the effects of media-multitasking on the various forms of creative performance. Our results provided new insights about: (1) the positive associations of habitual media-multitasking with specific aspects of creativity, (2) the individual factors that potentially enhance or attenuate these associations, and (3) the influence of different analytical strategies regarding media-multitasking scores on our findings. In this section, we discuss the implications of our main findings, the limitations of the present work, and future research directions.

4.1. Positive associations of habitual media-multitasking with convergent thinking and divergent thinking task performance, but not real-life creative achievement

Existing literature has demonstrated links between increased media-multitasking levels and breadth-biased attention control tendencies, as well as links between broadened attentional scopes and better creative performance. Bridging these findings, the present work hypothesized that increased habitual media-multitasking would relate to (1) better convergent thinking performance, as typically measured by the Remotes Associates Task (RAT), (2) increased fluency, originality, and flexibility scores, but decreased elaboration scores on the Alternate Uses Task (AUT), a typical measure of divergent thinking, and (3) higher real-life creative achievement questionnaire (CAQ) scores. Our analyses supported the above predictions to varying extents: Whereas higher media-multitasking levels were associated with better performance on the RAT task, and higher fluency and originality scores on AUT task, no significant associations of media-multitasking were observed with the flexibility and elaboration components of AUT and real-life creative achievement scores.

Convergent thinking. Our finding that higher media-multitasking levels are associated with better convergent thinking performance is in line with previous reports that individuals who tend to adopt a wider attentional span performed better on the RAT task (Mendelsohn, 1976; Zmigrod et al., 2015, 2019). Previous work has consistently shown that high media-multitaskers (HMMs) tend to engage in breadth-focused attention control (Loh & Kanai, 2016): They exhibit reduced top-down filtering of information (Ophir et al., 2009) and increased tendencies to process task-irrelevant information even when instructed otherwise (Cain & Mitroff, 2011), and are better at assimilating non-attending information to aid performance on a primary task (Lui & Wong, 2012) and at splitting their attentional focus (Yap & Lim, 2013). This form of attentional control has been associated with the increased, unfiltered access to information that enables an individual to form associations between otherwise disparate ideas or stimuli (Kasof, 1997; Mendelsohn, 1976). The RAT task required the generation of a single solution word that is typically weakly associated with each of the three target words. As such, the solver would have to access a broader range of associations (beyond the typical words that are more strongly associated with each single target word) in order to find a solution that matches all three target words. Moreover, in the present version of the task, there was limited time available for solving each problem. This constraint compels the solver to access a broad range of associated words and to devise a solution within a short time. Under such a circumstance, HMMs, with their breadth-biased attention control, would be able to access a wider range of associated words and to find the correct solution more quickly, compared to LMMs. Notably, our analyses have revealed no significant differences in demographic and personality differences between HMMs and LMMs, which included age, gender, general intelligence, impulsivity, and the big personality traits (Table 3). Thus, the difference in performance between the two groups is likely driven by their differences in habitual media-multitasking. The present data has evidenced, for the first time, a positive relationship between habitual media-multitasking and convergent thinking, which we argue to be driven by attentional differences that emerge from increased media-multitasking. A direct test of this proposition will require an investigation of how attentional control abilities might moderate or mediate the link between media-multitasking and convergent thinking, which constitutes a promising avenue of future research.

Divergent thinking. The present study revealed that higher media-multitasking levels were positively related to higher fluency and originality scores on the Alternative Uses Task (AUT). This result was congruent with previous findings (Zabelina & Ganis, 2018b; Zabelina et al., 2015, 2016) which suggested that divergent thinking, in terms of originality and fluency on the AUT, is enhanced by an attentional mode that is flexible (i.e., the scope or target of attention focus can be freely adjusted or switched) and selective (i.e., a certain degree of cognitive control is still involved to ensure the processing of goal-related information). We argued earlier that this form of attentional control resembles the breadth-biased attention mode that is associated with increased media-multitasking as individuals have to constantly monitor multiple streams of media, and actively switch their focus from one or more media streams to others. On the AUT, the originality score depends on the subject's ability to conceive object uses that are unique, compared to other subjects. In this context, a breadth-focused attentional control could boost originality scores by increasing access to more atypical ideas that would otherwise be filtered out under a narrower, focused attentional control mode. In the same vein, fluency requires the generation of more object uses which, again, is presumably augmented by a breath-biased attentional mode, providing unfiltered access to more ideas and information.

We had predicted that flexibility—the ability to generate more categories—would be positively related to media-multitasking, since a breadth-focused attention style would result in a larger range of categories to be conceived (Colzato et al., 2012). At odds with this prediction, media-multitasking level did not relate to better flexibility performance. A parsimonious interpretation is that the form of breadth-focused attention control required for enhanced flexibility involves a higher degree of executive control than that possessed by heavy media-multitaskers. Similarly, high media-multitaskers do not perform better in terms of elaboration, which likely necessitates a high level of cognitive control and focus. Future work ought to further determine the exact nature of the attentional control mechanisms exhibited by high media-multitaskers to reveal why they perform better in fluency and originality but not the elaboration and flexibility aspects of divergent thinking, relative to low media-multitaskers.

Real-life creative achievements. Lastly, contrary to our predictions, we found that HMMs and LMMs did not differ on their levels of real-life creativity achievements, even though HMMs performed better in terms of convergent thinking and some aspects of divergent thinking. One possibility is that, even though habitual media multitasking can benefit certain aspects of creativity, the attainment of real-life creativity achievements depends on other factors beyond pure creative potential which could be lacking in heavy media-multitaskers, such as the ability to persist on a particular task (Zabelina & Beeman, 2013). Another possibility is that the degree of homogeneity in terms of creative achievement across the various fields might be limited in the sample we recruited, which is composed almost entirely of undergraduate students from a single department. It will be interesting for future work to investigate the relationship between media-multitasking and real-life creativity across a diversity of samples.

4.2. Significant influences of fluid intelligence and attentional impulsivity on the relationship between media-multitasking and creative performance

Our analyses illuminated, for the first time, two individual factors that significantly moderate the associations of media-multitasking with creative performance. Specifically, we demonstrated that an individual's level of *fluid intelligence* and *attentional impulsivity* can significantly moderate the association of habitual media-multitasking with one's creative performance: While fluid intelligence *enhances* the positive association of media-multitasking with creative performance, attentional impulsivity *attenuates* the positive association of media-multitasking with creative performance.

We had theorized that increased habitual media-multitasking might promote better creativity through the development of a breadth-biased attention style, based on literature that evidences links between habitual media-multitasking and breadth-biased attention (Loh & Kanai, 2016; Uncapher & Wagner, 2018), and links between broadened attention scopes and creative performance (Kasof, 1997). The present results refine this theory by suggesting that the breadth-biased attention mode associated with higher media-multitasking might not always be beneficial for creativity, which depends on an individual's level of fluid intelligence and attentional impulsivity. Importantly, the positive associations of creativity with media-multitasking also vary across the different types of creativity measures studied, suggesting that the relationship between media-multitasking and creativity is highly complex and warrants further investigation. Notwithstanding, our findings underscore the importance of taking into account individual factors when examining the cognitive nature of media-multitasking, and offer practical value for modern-day educators who seek to maximize the creative potential of learners. For instance, in today's educational landscape where media-multitasking behaviors are quickly becoming the norm, educators could veer existing educational programs toward cultivating learners' fluid intelligence, whilst diminishing their attentional impulsivity levels.

4.3. Heterogeneity in findings based on different approaches to analyze media-multitasking scores

Recent reviews (e.g., Uncapher & Wagner, 2018) about the cognitive nature of media-multitasking have noted heterogeneous findings across studies, which could be related to the variety of approaches adopted to analyze media-multitasking index (MMI) scores. In the present study, we had adopted three common methods used to analyze MMI scores: (1) using MMI scores as a continuous predictor in a regression analyses, (2) group comparisons of high versus low media-multitaskers based on a median-split on the MMI scores, and (3) extreme group comparisons with high and low media-multitaskers identified based on MMI scores of a standard deviation above and below the mean. We obtained differential findings from the three methods. Of the three approaches, only the median-split analyses revealed significant effects of media-multitasking on creative performance.

One interpretation is that the true underlying relationship between media-multitasking and creativity is more nuanced than previously thought, and potentially non-monotonic, resulting in null findings on the extreme-group and regression analyses. Indeed, some studies have reported that u-shaped relationships might exist between media-multitasking and cognitive performance with intermediate media-multitasking levels showing superior performance relative to lower and higher levels (Cardoso-Leite et al., 2015), while others have reported contradictory evidence (Edwards & Shin, 2017). With the median-split approach, the categorization of MMI scores into two artificial groups with higher versus lower scores might have attenuated the non-monotonic properties of the distribution, leading to the observed significant group differences. As an important caveat, one should therefore exercise caution when interpreting the present results. As an exploratory study, however, our work intends to revealthe over-arching trend that higher levels of media-multitasking scores relate to better creative performance. Moving forward, more work is necessary to investigate the true nature of the relationship between media-multitasking and creative performance via a larger sample, in order to determine the appropriate—optimal—statistical approach for such data.

4.4. Limitations and future directions

It is noteworthy that the current study reveals a link, rather than any causal relationship, between MMI scores and creativity performance. To establish any directionality between the variables, an experimental study would be useful, wherein individuals are randomly subject to either high or low media-multitasking settings whilst undertaking the AUT and RAT, thereby further showing whether HMMs can in fact harness their creativity potential even when subject to high-media multitasking scenarios, i.e., whether HMMs can only be creative when they, in fact, stop multitasking. Alternatively, a longitudinal study would aid in understanding the long-term development of individuals' media consumption patterns vis-à-vis their creative abilities in, e.g., real-world educational contexts over time.

A further question of interest relates to the relative importance of the increase in breadth-focused attentional control over other factors that are hurt by media multitasking. In other words, it may be useful to investigate the positive effect of high media multitasking on creativity through breadth-focused attentional control in light of other negative findings of high media multitasking on such variables as depression and anxiety (Becker et al., 2013), which would likely decrease creativity based on the link between positive mood and creativity (Davis, 2009), or the negative effects on cognitive variables like deficits in working memory and long-term memory as earlier discussed.

Finally, the sample in the present study consists mainly of young undergraduate students who may tend to be homogeneous in many psychosocial aspects, such as socio-economic status and educational backgrounds. Future work can explore the relationships between media-multitasking and creativity in more varied samples to extend the generalisability of the current findings.

5. Conclusion

In the current educational landscape, there had been mounting concerns about the potential detrimental effects of the rapidly rising media-multitasking trends on educational outcomes and achievements. The current work pioneered an investigation of the association between media-multitasking and creativity, a vital educational outcome, as well as the individual factors that potentially moderate this association. Importantly, the findings revealed positive associations between media-multitasking with two key creative processes, namely convergent and divergent thinking, and the roles of fluid intelligence and attentional impulsivity in moderating these associations. Notably, the above findings obtained only when media-multitasking scores were analysed via a median-split approach, but not via an extreme-group approach or a regression with the scores as a continuous predictor, suggesting that the relationship between media-multitasking and creative performance might be more nuanced than previously assumed. Future work should eludicate the complex nature of this relationship using larger and more varied samples.

Author notes

This research was supported in part by a National University of Singapore Faculty of Arts and Social Sciences Heads and Deanery Research Support Scheme grant (R-581-000-192-101) awarded to Stephen Wee Hun Lim. We thank Yushi Wang for data collection, and Kagen Y. L. Lim and Gabriel RongYang Lau for data coding.

Declaration of competing interest

Both authors report no conflicts of interest in regard to publishing the present work.

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