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BRIEF REPORT

Partitioning switch costs when investigating task switching in relation to media multitasking

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Abstract
The prevalence of media multitasking – the concurrent use of multiple forms of media – has motivated research on whether and how it is related to various cognitive abilities, such as the ability to switch tasks. However, previous research on the relationship between media multitasking and task-switching performance has yielded mixed results, possibly because of small sample sizes and a confound between task and cue transitions that resulted in switch costs being impure measures of task-switching ability. The authors conducted a large-sample study in which media multitasking behavior was surveyed and task-switching performance was assessed using two cues per task, thereby allowing switch costs to be partitioned into task-switching and cue-repetition effects. The main finding was no evidence of any relationship between media multitasking scores and task-switching effects (or cue-repetition effects), either in correlational analyses or in extreme group analyses of light and heavy media multitaskers. The results are discussed in the context of previous research, with implications for studying media multitasking in relation to task-switching performance.

Keywords Media multitasking · Task switching · Switch cost · Cue repetition · Individual differences

Introduction

Media use is increasingly common in everyday life. From 1999 to 2009, media use by American youth grew over 20% to about 7.5 h per day (Rideout, Foehr, & Roberts, 2010). A more recent survey indicated that American teenagers spend nearly 9 h per day engaged in media activities that include listening to music, watching television, playing video games, and using social networking sites (Common Sense, 2015). The rise in media use is paralleled by an increase in media multitasking – the concurrent use of multiple forms of media, such as texting on a smartphone while watching television, or listening to music while reading email (Rideout et al., 2010). The prevalence of media multitasking in the USA and in other countries (Voorveld, Segijn, Ketelaar, & Smit, 2014) has motivated research on whether and how it is related to various cognitive abilities, such as the ability to switch tasks (for a review, see Uncapher & Wagner, 2018). The purpose of the present study was to investigate the relationship between media multitasking and task-switching performance.

Previous studies on this topic share some design features. Media multitasking is typically assessed with self-report surveys. Ophir, Nass, and Wagner (2009) introduced a survey in which subjects indicated how much time per week they used 12 types of media and how often they concurrently used different pairs of media. Responses were used to calculate media multitasking scores that allowed subjects to be classified as light or heavy media multitaskers (individuals who rarely or frequently engaged in media multitasking, respectively). Recently, researchers have developed revised surveys to obtain updated and refined measures of media multitasking (e.g., Alzahabi, Becker, & Hambrick, 2017; Baumgartner, Lemmens, Weeda, & Huizinga, 2017).

Task-switching performance is typically assessed with experimental paradigms involving categorization tasks. For example, Ophir et al. (2009) used a paradigm in which subjects performed letter and number tasks on alphanumeric stimuli (e.g., *a3*), with the relevant task on each trial indicated by a word cue. The letter task was cued by the word *LETTER* and involved categorizing the letter stimulus as a consonant or a vowel, whereas the number task was cued by the word *NUMBER* and involved categorizing the number stimulus as odd or even. Some trials were task switches (e.g., number task followed by letter task) and other trials were task repetitions (e.g., letter task followed by letter

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task). Response times (RTs) for task-switching performance revealed switch costs: RTs were longer for task switches than for task repetitions. Switch costs are routinely found in task-switching studies and interpreted as indices of cognitive control processes that enable flexible, goal-directed behavior in multitasking situations (for reviews, see Kiesel et al., 2010; Vandierendonck, Liefooghe, & Verbruggen, 2010).

An issue of interest is whether there is any relationship between media multitasking and task-switching performance. For example, heavy media multitaskers might be better than light media multitaskers at switching tasks, either because their general task-switching ability is improved by frequent media multitasking or because an intrinsically strong task-switching ability promotes media multitasking. However, studies of the relationship between media multitasking and task-switching performance have yielded mixed results (for a summary, see Uncapher & Wagner, 2018). Some researchers obtained evidence consistent with the pattern described earlier, such that media multitasking scores were negatively correlated with switch costs (Alzahabi & Becker, 2013; Elbe, Sörman, Mellqvist, Brändström, & Ljungberg, 2019). Other researchers found the opposite pattern, with larger switch costs for heavy than for light media multitaskers (Ophir et al., 2009; Wiradhany & Nieuwenstein, 2017, Experiment 1). Null results also have been reported in several studies (Alzahabi et al., 2017; Baumgartner, Weeda, van der Heijden, & Huizinga, 2014; Cardoso-Leite et al., 2016; Gorman & Green, 2016; Minear, Brasher, McCurdy, Lewis, & Younggren, 2013; Wiradhany & Nieuwenstein, 2017, Experiment 2).

There are many possible reasons for the mixed results in the literature. An overarching possibility is that there is no systematic relationship between media multitasking and task-switching performance, in which case one would expect several null results but occasionally also significant results by chance. However, some previous findings might reflect methodological issues, two of which we address in the present study. One issue is that most past studies involved small sample sizes. In the nine studies cited in the preceding paragraph, the median sample size was 20 subjects in each of the light and heavy media multitasking groups, providing less than 40% power to detect a medium-sized effect ($d = 0.5$) for a difference in switch costs between groups (Faul, Erdfelder, Lang, & Buchner, 2007). In the studies in which significant negative correlations between media multitasking scores and switch costs were obtained (Alzahabi & Becker, 2013; Elbe et al., 2019), the sample sizes of 80 or fewer subjects provided less than 80% power to detect the mean correlation ($r = -.29$). Notably, a nonsignificant correlation was obtained in a high-powered study with over 500 subjects (Baumgartner et al., 2014). Thus, the mixed results across studies could have arisen from generally low statistical power for detecting a relationship (if one exists) between media multitasking and task-switching performance.

A second issue is that the switch costs in several past studies were impure measures of task-switching ability. In the previously described task-switching paradigm used by Ophir et al. (2009) and subsequently by others (Alzahabi & Becker, 2013; Cardoso-Leite et al., 2016; Minear et al., 2013; Wiradhany & Nieuwenstein, 2017), task transitions were confounded with cue transitions: whenever the task switched (e.g., number task followed by letter task), the cue also switched (*NUMBER* followed by *LETTER*); whenever the task repeated (e.g., letter task followed by letter task), the cue also repeated (*LETTER* followed by *LETTER*). Consequently, with one cue per task, the "switch cost" measured as the performance difference between task switches and task repetitions could have reflected task switching or cue switching (or both).

There is abundant evidence from the task-switching literature that the confound matters for interpreting switch costs (for a review, see Jost, De Baene, Koch, & Brass, 2013). The evidence comes from experiments in which the confound was broken by using two cues per task, resulting in three types of transitions: task switches (task and cue both switch), cue repetitions (task and cue both repeat), and task repetitions (task repeats but cue switches, which occurs when the two cues assigned to the same task are used on consecutive trials). Task switches and cue repetitions are the same transitions used to calculate switch costs in experiments with one cue per task. The introduction of task repetitions allows switch costs to be partitioned into two components: task-switching effects (performance differences between task switches and task repetitions) and cue-repetition effects (performance differences between task repetitions and cue repetitions). Task-switching and cue-repetition effects are both often found when using two cues per task (e.g., Logan & Bundesen, 2003, 2004; Mayr & Kliegl, 2003; Monsell & Mizon, 2006; Schneider & Logan, 2005, 2006, 2011). The frequent finding of cue-repetition effects – which are calculated from trials that do not involve task switching – suggests that the "switch costs" measured using one cue per task reflect more than just task-switching ability.

This finding is important in the present context because the contribution of cue-repetition effects to switch costs has not been directly addressed in past studies on the relationship between media multitasking and task-switching performance. In most of the studies cited earlier, task transitions were confounded with cue transitions because there was one cue per task. Two exceptions are the studies by Elbe et al. (2019) and Baumgartner et al. (2014). In one condition of Elbe et al.'s study, stimulus location cued the relevant task, with two locations mapped to each task. However, the data were not analyzed based on whether the location cue repeated or switched when the task repeated, resulting in switch costs that might have included cue-repetition effects. In Baumgartner et al.'s study, there were no cues because the tasks occurred in a predictable order and the stimulus displays were univalent (i.e., they afforded only one task), and switch costs were unrelated to media multitasking.

Considering that the switch costs in most previous studies likely included cue-repetition effects, the mixed results in the media multitasking literature might be partly attributable to switch costs being impure measures of task-switching ability. To elaborate, imagine that media multitasking is related to task-switching effects but not to cue-repetition effects. Whether a relationship will be detected when analyzing switch costs in an experiment with one cue per task will depend on how much of the switch cost is a task-switching effect. The greater the contribution of an unrelated cue-repetition effect to the switch cost, the less likely one will detect any task-switching relationship because the switch cost will be a noisier measure of task-switching ability.

Task-switching research with two cues per task has revealed that the relative contribution of cue-repetition effects to switch costs is neither trivial nor constant across studies. Logan, Schneider, and Bundesen (2007) examined the results of several studies and found that cue-repetition effects were large and highly variable across experiments (mean of 154 ms; range of 52–367 ms), representing the majority of the switch costs in over 85% of cases. Monsell and Mizon (2006) found that whether cue-repetition effects were larger or smaller than task-switching effects depended on the specific tasks and cues used. Thus, previous results in the media multitasking literature could reflect unknown variation in the contribution of cue-repetition effects to switch costs across studies. Moreover, cue-repetition effects – not just task-switching effects – might be associated with media multitasking. For example, if both transition effects were related to media multitasking but in opposite directions, then their relative contributions to switch costs could determine whether a positive, negative, or null relationship is found when switch costs are analyzed, which could explain some of the mixed results in the literature.

We addressed these issues by conducting a large-sample study in which media multitasking behavior was surveyed and task-switching performance was assessed using two cues per task. One hundred seventy subjects completed a media multitasking survey (from Baumgartner et al., 2017) and then performed color and shape tasks on visual stimuli, where the relevant task on each trial was indicated by a letter cue, and two cues were assigned to each task (adapted from Schneider, 2016). For example, some subjects had the letters *B* and *E* as cues for the color task and the letters *D* and *G* as cues for the shape task (see Fig. 1a). With two cues per task, we could measure performance for task switches, task repetitions, and cue repetitions, which allowed us to partition switch costs into task-switching and cue-repetition effects (see Fig. 1b). We analyzed the data in the two main ways used in previous research. First, we calculated correlations between media multitasking scores and transition effects for the full sample. Second, we formed extreme groups of light and heavy media multitaskers and compared transition effects between groups. Our study design enabled us to estimate the relative contributions of task-switching and cue-repetition effects to switch costs, and also examine whether each transition effect was associated with media multitasking. We were particularly interested in whether a reliable relationship between media multitasking and task-switching performance would be detected when the latter was based on a purer measure of task-switching ability (task-switching effects isolated from cue-repetition effects).[1]

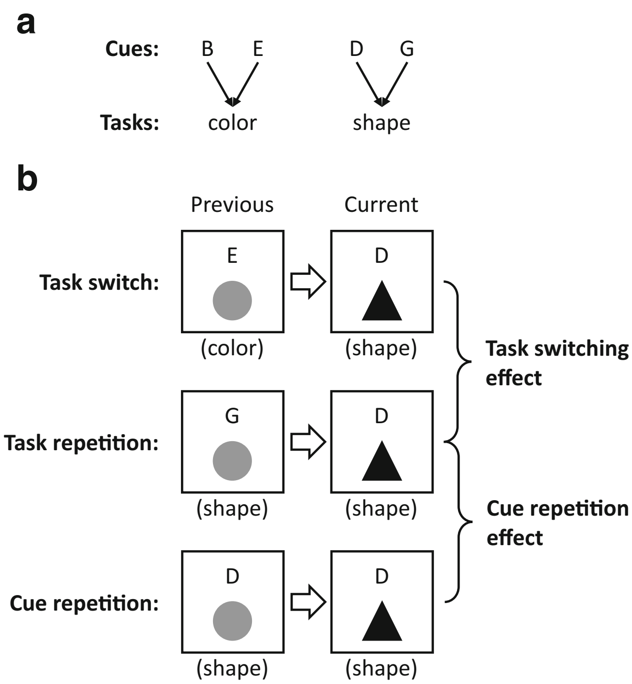

Fig. 1 **a** Example cue–task mappings. **b** Example transitions and associated transition effects

Method

Subjects

A total of 170 undergraduate students (103 female; 156 right-handed; mean age = 18.8 years) from Purdue University participated for course credit and had their data included in the

[1] The study was preregistered and the data are publicly available (see Open Practices Statement).

[0] We excluded data from 11 additional subjects, all but one on the basis of preregistered exclusion criteria. Seven of these subjects had mean error rates for one or both tasks in the task switching phase that exceeded 20%. Two subjects did not follow the experimenter's instructions while the instructions were being given (their data were discarded without any analysis). One subject did not answer all items on the media multitasking survey. Finally, one subject had a grand mean RT in the task switching phase that was 7.5 standard deviations above the group mean, with 16% of RTs longer than 10 s. We did not preregister a subject-level exclusion criterion based on RT, but we deemed that subject's data to be highly unusual and aberrant enough to justify exclusion.

reported analyses.[2] We preregistered a target sample size of 168 subjects based on a power analysis (calculated using G*Power; Faul et al., 2007) that indicated 164 subjects would provide 90% power to detect a correlation of $|r| = .25$, similar to the smallest correlation ($r = -.254$) between media multitasking scores and switch costs obtained by Alzahabi and Becker (2013). The sample size from the power analysis was increased to 168 subjects to accommodate counterbalancing of cue–task and category–response mappings across subjects in the task-switching phase. Our obtained sample size of 170 subjects exceeded the preregistered target because extra subjects were available during the final week of data collection. All subjects reported having normal or corrected-to-normal vision.

Apparatus

The study was conducted using E-Prime 3 (Psychology Software Tools, Inc.) on desktop computers with monitors positioned at a viewing distance of about 50 cm. Each computer was equipped with a mouse and a Chronos response box (Psychology Software Tools, Inc.).

Media multitasking

We assessed media multitasking with the survey developed by Baumgartner et al. (2017), which is shorter than the survey used by Ophir et al. (2009), reflects more recent media technology usage, and has better psychometric properties. In a large-sample study ($N = 523$), Baumgartner and colleagues found that their short survey had high reliability (Cronbach's alpha = .90) and yielded media multitasking scores that were highly correlated ($r = .82$) with the scores from a longer version of the survey. The survey consists of nine items asking subjects to rate how often they concurrently engage in different forms of media use (e.g., using social networking sites while watching television). Each item was rated on a scale with the following options: 1 ("never"), 2 ("sometimes"), 3 ("often"), 4 ("very often"). The mean numerical rating across all items constituted a subject's media multitasking score.

As in Study 2 of Baumgartner et al. (2017), we also surveyed the frequency of media use by asking subjects to rate how much time they spend using specific forms of media (e.g., watching television) during a typical day. Each of three items was rated on a scale with the following options: 1 ("not at all"), 2 ("less than 30 min"), 3 ("30 min–1 h"), 4 ("1–2 h"), 5 ("2–3 h"), 6 ("3–4 h"), 7 ("4–5 h"), 8 ("more than 5 h"). The mean numerical rating across all items constituted a subject's media use score.

Survey items were presented in white 18-pt Arial font on a black background. Subjects responded by using the computer mouse to select an option for each item, without any time pressure.

Task switching

We assessed task-switching performance with a simplified version of the paradigm used in Schneider (2016). Subjects repeated and switched between color and shape tasks performed on visual stimuli. The color task involved categorizing the stimulus color as red or yellow, whereas the shape task involved categorizing the stimulus shape as a circle or a triangle. The stimuli were a red circle, yellow circle, red triangle, and yellow triangle, each measuring 2.4 cm × 2.4 cm.

The relevant task (color or shape) to be performed on the stimulus for each trial was indicated by a cue. The cues were the letters *B*, *D*, *E*, and *G*, each displayed in white 24-pt Arial font. Two cues were assigned to each task. For example, some subjects had the color task cued by *B* or *E*, and the shape task cued by *D* or *G* (see Fig. 1a). Subjects had to memorize which cues indicated each task. Cue–task mappings were counterbalanced across subjects.

Subjects categorized the stimulus according to the cued task by using their left or right index finger to press the leftmost or rightmost button, respectively, on the response box. They were instructed to respond quickly and accurately. Categories associated with the same task were assigned to different response buttons. For example, some subjects pressed the left button for red and the right button for yellow when performing the color task, and they pressed the left button for circle and the right button for triangle when performing the shape task. Category–response mappings were counterbalanced across subjects. Reminders of a subject's designated category–response mappings appeared at the bottom of the screen.

Subjects completed five blocks of 64 trials per block. Each trial consisted of a sequence of three displays, all with black backgrounds. First, a white fixation cross was presented centrally for 500 ms. Second, the fixation cross was replaced by a cue, which was presented 2.2 cm above a stimulus. The cue and the stimulus appeared simultaneously and remained visible until a response button was pressed (RT and accuracy were recorded), then the screen was cleared. Third, a blank screen was displayed for 500 ms before the start of the next trial.

The cue and the stimulus were randomly selected for each trial, subject to the constraint that every cue–stimulus combination occurred equally often in each block of trials. The random selection of cues resulted in three types of transitions across trials: task switches, task repetitions, and cue repetitions (see Fig. 1b). A task switch occurred when the cue on the current trial indicated a different task than the cue on the previous trial. A task repetition occurred when the cues differed on the current and previous trials, but both cues indicated the same task. A cue repetition occurred when the same cue was presented on the current and previous trials. Task switches occurred on approximately 50% of trials, whereas task repetitions and cue repetitions each occurred on approximately 25% of trials.

Procedure

Subjects participated individually in private rooms after providing informed consent for a study protocol approved by the Purdue University Institutional Review Board. The study was divided into two parts completed in a single session. In the first part, subjects filled out the media multitasking survey described earlier. In the second part, they completed the task-switching phase, which began with instructions presented onscreen and read aloud by the experimenter. During the instructions, subjects performed eight example trials (with accuracy feedback) that included two instances of each cue and two instances of each stimulus. After the instructions, subjects performed the blocks of trials described earlier (without accuracy feedback).

Results

Each subject's media multitasking and media use scores were calculated as described earlier. For the task-switching phase, data trimming followed the preregistered protocol. The first block of trials and the first trial of each subsequent block were excluded. Trials with RTs more than three standard deviations above a subject's cell mean were excluded (2.2% of trials). Error trials were excluded from the RT analyses. Mean RTs and mean error rates were calculated for each subject as a function of transition (task switch, task repetition, or cue repetition). Our preregistered analyses are reported in the subsections titled *Correlational analyses* and *Extreme group analyses*. We start by reporting statistics in the *Preliminary analyses* subsection that were not preregistered but we think are informative.

Preliminary analyses

Media multitasking The mean media multitasking score was 2.58 ($SD = 0.57$; range = 1.33–4.00; Cronbach's alpha = .85). The mean media use score was 3.89 ($SD = 1.02$; range = 2.00–7.67). Media multitasking and media use scores were positively correlated, $r(168) = .38$, $p < .001$, replicating the relationship found in Study 2 of Baumgartner et al. (2017).

Task switching Mean RTs and mean error rates were submitted to one-way, repeated-measures analyses of variance (ANOVAs) with transition as the factor.[3] There was a significant effect of transition in the RT data, $F(1.84, 311.59) = 201.61$, $p < .001$, $\eta_p^2 = .54$. Mean RTs were 1,752 ms for task switches, 1,598 ms for task repetitions, and 1,321 ms for cue repetitions. The task-switching effect of 154 ms (the RT difference between task switches and task repetitions) was significant, $t(169) = 8.36$, $p < .001$, $d = .64$, as was the cue-repetition effect of 277 ms (the RT difference between task repetitions and cue repetitions), $t(169) = 12.22$, $p < .001$, $d =$ 94. Task-switching and cue-repetition effects were negatively correlated, $r(168) = -.34$, $p < .001$. These results replicate the RT pattern found with letter cues in Experiment 2 of Schneider (2016).[4] There was no significant effect of transition in the error data, $F(2, 338) = 1.70$, $p = .19$. Mean error rates were 3.6% for task switches, 3.5% for task repetitions, and 3.2% for cue repetitions. Despite the nonsignificant transition effect on error rates at the group level, task-switching and cue-repetition effects were negatively correlated, $r(168) = -.48$, $p < .001$, mirroring the RT data.

Correlational analyses

Task-switching and cue-repetition effects on RTs are plotted against media multitasking scores in Fig. 2. Task-switching effects were not significantly related to media multitasking scores (see Fig. 2a), $r(168) = .00$, $p = .981$. Cue-repetition effects also were not significantly related to media multitasking scores (see Fig. 2b), $r(168) = .05$, $p = .484$. Similar results were obtained for the error data: Task-switching effects were unrelated to media multitasking scores, $r(168) = .02$, $p = .807$, and cue-repetition effects were unrelated to media multitasking scores, $r(168) = -.07$, $p = .339$. As described earlier, task-switching and cue-repetition effects were negatively correlated with each other for both RTs and error rates.

Extreme group analyses

We formed light and heavy media multitasking groups ($n = 40$ per group) based on subjects having media multitasking scores in the lower 23.5% (below 2.11; light group) or upper 23.5% (above 2.89; heavy group) of the distribution.[5] Descriptive statistics for both groups are provided in Table 1. Mean RTs and mean error rates from the task-switching phase were submitted to mixed ANOVAs with group as a between-subjects factor and transition as a within-subjects factor. There was a significant main effect of transition in the RT data, $F(1.73, 134.94) = 102.05$, $p < .001$, $\eta_p^2 = .57$, consistent with the results for the full sample. However, the main effect of group was nonsignificant, $F(1, 78) = 2.00$, $p = .161$, as was the interaction between transition

[3] ANOVA results are reported with degrees of freedom adjusted using the Greenhouse-Geisser procedure whenever sphericity was violated.

[4] A reanalysis of the corresponding data from Schneider (2016) also revealed a significant negative correlation between task-switching and cue-repetition effects, $r(46) = -.31$, $p = .030$.

[5] Our preregistered protocol indicates that we intended to form extreme groups based on the lower 25% and upper 25% of the distribution of media multitasking scores. However, our obtained sample size and the granularity of media multitasking scores did not enable cutoffs of exactly 25%; therefore, we used cutoffs that were as close as possible to 25%.

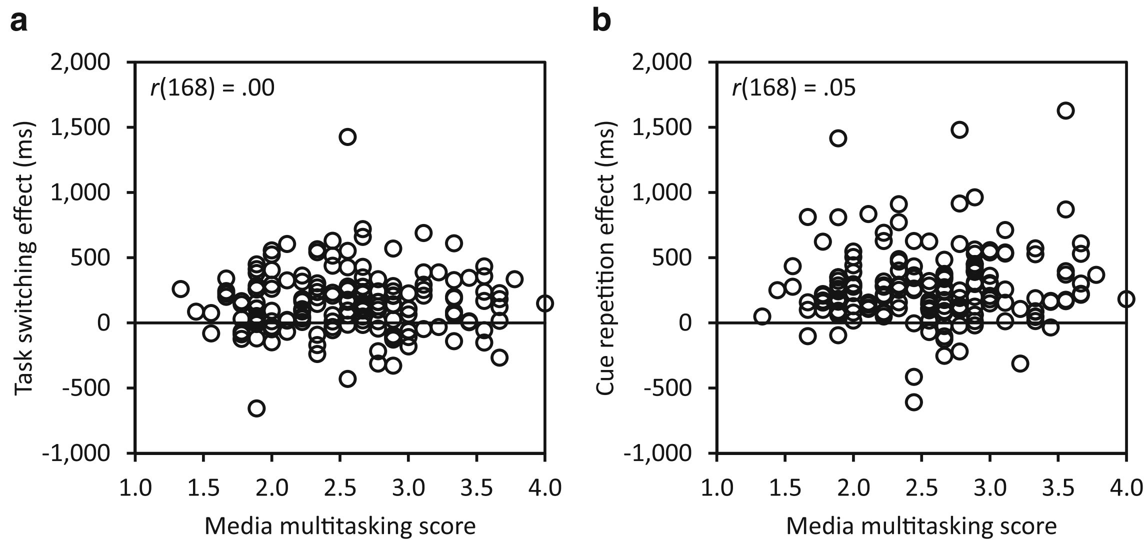

Fig. 2 **a** Media multitasking scores versus task-switching effects. **b** Media multitasking scores versus cue-repetition effects. In both scatter plots, circles represent data from individual subjects

and group, $F(1.73, 134.94) = 0.29$, $p = .716$. The nonsignificant interaction reflects the relatively small numerical differences between the heavy and light media multitasking groups in task-switching effects (17-ms difference) and cue-repetition effects (29-ms difference). There were no significant effects in the error data: main effect of transition, $F(2, 156) = 0.70$, $p = .501$; main effect of group, $F(1, 78) = 0.34$, $p = .563$; interaction between transition and group, $F(2, 156) = 0.43$, $p = .653$.

Discussion

The relationship between media multitasking and task-switching performance is a subject of recent research, but there are mixed results in the literature (for a review, see Uncapher & Wagner, 2018). This situation might be partly attributable to two methodological issues in previous studies. First, sample sizes were often relatively small, providing low statistical power to detect a relationship (if one exists). Second, task transitions were confounded with cue transitions because there was one cue per task, yielding switch costs that were impure measures of task-switching ability. These issues might have adversely affected past efforts to ascertain whether and how media multitasking is related to task-switching performance.

We addressed these issues by conducting a large-sample study ($N = 170$) in which media multitasking behavior was surveyed and task-switching performance was assessed using two cues per task, thereby allowing switch costs to be partitioned into task-switching and cue-repetition effects. Our media multitasking data are consistent with past results in showing a significant positive correlation between media multitasking and media use scores (Baumgartner et al., 2017). Our task-switching data are consistent with past results in

Table 1 Descriptive statistics for the light and heavy media multitasking groups

Data type	Statistic	Media multitasking group	
		Light ($n = 40$)	Heavy ($n = 40$)
Media use score	Mean [range]	3.39 [2.00–6.33]	4.30 [2.33–7.00]
Media multitasking score	Mean [range]	1.84 [1.33–2.00]	3.34 [3.00–4.00]
Transition RT (ms)			
Task switch	Mean (SE)	1,829 (89)	1,714 (70)
Task repetition	Mean (SE)	1,702 (84)	1,570 (65)
Cue repetition	Mean (SE)	1,419 (70)	1,258 (49)
Transition effect on RT (ms)			
Task-switching effect	Mean (SE)	127 (35)	144 (33)
Cue-repetition effect	Mean (SE)	283 (43)	312 (50)

RT response time, *SE* standard error

showing large task-switching and cue-repetition effects on RTs (e.g., Logan & Bundesen, 2004; Mayr & Kliegl, 2003; Monsell & Mizon, 2006; Schneider & Logan, 2011), as well as a significant negative correlation between those effects (Schneider, 2016). The cue-repetition effect represented nearly two-thirds of the overall switch cost, which fits with previous observations (Logan et al., 2007) and strongly suggests that the switch cost obtained in contexts with one cue per task is indeed an impure measure of task-switching ability.[6]

Critically, we obtained no evidence of any relationship between media multitasking scores and task-switching effects (or cue-repetition effects), either in correlational analyses of data for the full sample (see Fig. 2) or in extreme group analyses of data for light and heavy media multitaskers (see Table 1). These findings are consistent with past null results concerning the relationship between media multitasking scores and switch costs (Alzahabi et al., 2017; Baumgartner et al., 2014; Cardoso-Leite et al., 2016; Gorman & Green, 2016; Minear et al., 2013; Wiradhany & Nieuwenstein, 2017, Experiment 2). However, the present study provides novel evidence that the null relationship holds when the purer task-switching component of the switch cost is isolated from the cue-repetition component. The present results also indicate that the null relationship is not an artifact of both transition effects being related to media multitasking but in opposite directions, a possibility mentioned earlier. Instead, neither transition effect was related to media multitasking.

Considering our findings in conjunction with the mixed results in the literature, the balance of evidence seems to indicate that there is no clear relationship between media multitasking and task-switching performance. A similar conclusion was reached by Wiradhany and Nieuwenstein (2017) on the basis of replication studies and a meta-analysis. We want to emphasize that this conclusion applies specifically to switch costs (or the task-switching portion of switch costs) as measures of task-switching performance. Switch costs in RTs can be problematic in research on individual differences (Draheim, Hicks, & Engle, 2016)[7] and it is possible that media multitasking is related to alternative measures or to a different aspect of task-switching behavior, such as preparation (Alzahabi et al., 2017).

If a relationship between media multitasking and task-switching performance exists and we simply did not detect it, then it could be weak, in which case we echo Wiradhany and Nieuwenstein's (2017) recommendation for high-powered studies. Additionally, it could be important to consider ecological validity when investigating the relationship. Even though media multitasking involves task switching (e.g., switching back and forth between watching television and texting on a smartphone), media-based tasks are often more complex, continuous, and qualitatively different than the simple, discrete categorization tasks routinely used in laboratory experiments (e.g., letter and number tasks; Ophir et al., 2009). Consequently, the switch costs measured in such experiments might not tap into the same kind of task-switching ability that is engaged during media multitasking. Exploring task switching in the laboratory with a variety of tasks, especially those that share features with media-based tasks, could be a worthwhile endeavor in future studies.

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Open Practices Statement The data are publicly available (https://osf.io/z8btw/) and the study was preregistered (https://aspredicted.org/vn2d9.pdf). The materials are available upon request from Darryl W. Schneider.

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[6] A prominent interpretation of cue-repetition effects is that they reflect priming of cue encoding – facilitation of the process by which an internal representation of the task cue is formed in memory (e.g., Logan & Bundesen, 2003; Schneider, 2016; Schneider & Logan, 2005, 2006).

[7] Draheim et al. (2016) noted that switch costs in RTs can have low reliability, which is an issue when they are used to examine individual differences in task-switching ability. We calculated split-half reliabilities in the present study using the RTs from odd- and even-numbered trials and the Spearman–Brown formula. Reliability estimates were .53 and .62 for the task-switching and cue-repetition effects, respectively, which are moderate and within the range of previously reported values in task-switching research (e.g., Salthouse, Fristoe, McGuthry, & Hambrick, 1998).

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