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Dealing with media distractions: an observational study of computer-based multitasking among children and adults in the Netherlands

Susanne E. Baumgartner and Sindy R. Sumter

Amsterdam School of Communication Research, University of Amsterdam, Amsterdam, the Netherlands

ABSTRACT
The aim of this observational study was to investigate differences in computer-based multitasking among children and adults. Moreover, the study investigated how attention problems are related to computer-based multitasking and how these individual differences interact with age. Computer-based multitasking was observed for a 10-minute period among children (N = 164, aged 6–13) and adults (N = 160, aged 18–75) in the Netherlands. The findings indicated that individuals find it indeed difficult to focus their attention on a main activity in the presence of appealing media distractors. A main effect for age was qualified by an interaction effect between age and attention problems. There was a positive relationship between attention problems and computer-based multitasking only for children but not for adults. The findings indicate that particularly children with attention problems are easily distracted by other media activities.

Due to the ubiquitous nature of media, it has become increasingly difficult for individuals to focus their attention on a task without being distracted. For instance, while studying for school, children and adolescents frequently use media simultaneously, such as watching TV, listening to music, or using social networking sites (e.g., Rosen, Carrier, & Cheever, 2013). Rosen et al. (2013) have shown that, on average, adolescents and young adults switch from studying to media every six minutes. Although it has been argued that younger people are particularly unable to resist media distractions, this phenomenon is not limited to youth. Adults are also often distracted by media while working or studying (Eyrolle & Cellier, 2000; Jett & George, 2003). They may also experience difficulties in focusing on a single task, particularly when working on computers which include a variety of functions and provide many possibilities for distractions (Yeykelis, Cummings, & Reeves, 2014).

The phenomenon of using media while engaging in other activities has been called media multitasking (Wallis, 2010). Media multitasking while engaging in school- or work-related activities may be problematic as previous research has shown that multitasking leads to impaired task performance (Ellis, Daniels, & Jauregui, 2010; Wood et al., 2012), longer time...
needed for finishing a task (Bowman, Levine, Waite, & Gendron, 2010; Eyrolle & Cellier, 2000), and lower academic performance (for reviews, see Carrier, Rosen, Cheever, & Lim, 2015; Jeong & Hwang, 2016; Van der Schuur, Baumgartner, Sumter, & Valkenburg, 2015).

Most existing studies on media multitasking investigated adolescents and young adults, thus little is known about media multitasking among children. Investigating children is crucial for at least two reasons. First, today’s children grow up in a media-saturated environment that offers them a multitude of potential media distractions. These children do not only use media during leisure time but increasingly spend time on computers in school or for school-related tasks (OECD, 2015, p. 59). As yet, it remains unclear how they handle these media distractions. Second, important attentional control processes are not yet fully developed in children (Huizinga, Dolan, & van der Molen, 2006; Passow et al., 2013). Because these attentional control processes still need to develop, children may be more vulnerable to media distractions than adults (Courage, Bakhtiar, Fitzpatrick, Kenny, & Brandeau, 2015; Klimkeit, Mattingley, Sheppard, Farrow, & Bradshaw, 2004).

The aim of the present observational study is to investigate differences in one specific form of media multitasking, computer-based multitasking, among children and adults. Moreover, the study investigates how attention problems are related to computer-based multitasking and how these individual differences interact with age.

**Engagement in computer-based multitasking**

Computer-based multitasking is a very common form of media multitasking (Lenhart, Rainie, & Lewis, 2001). It can be broadly defined as switching between several unrelated tasks on a computer within a specific time frame (Benbunan-Fich, Adler, & Mavlanova, 2011). In the case of computer-based multitasking, switching happens in a serial manner (i.e., switching between different tabs on a computer) rather than concurrently (i.e., listing to music while reading a book). According to Yeykelis et al. (2014) computer-based multitasking may be internally or externally driven. A switch is externally driven when attention is guided to other media content by an external trigger, for example, when attention to a homework task is interrupted due to a pop-up notification of an incoming mail (Adler & Benbunan-Fich, 2012; Yeykelis et al., 2014). A switch is internally driven if someone actively chooses to switch from one media content to another on account of a specific psychological state, such as boredom. In the present study, we focus on computer-based multitasking that is internally driven.

Media multitasking is considered problematic because it is related to cognitive costs (e.g., Janssen, Gould, Li, Brumby, & Cox, 2015; Wang & Tchernev, 2012). A large body of research has shown that interruptions during work- or school-related activities lead to lower task performance, higher perceived stress, and mental fatigue (Eyrolle & Cellier, 2000; Jett & George, 2003). In the school context, studies have shown that engaging in media while doing homework or being in class is related to diminished processing of study content and decreased learning (for a review, see Van der Schuur et al., 2015). For example, Armstrong and Greenberg (1990) have shown that background television led to impaired reading comprehension, spatial problem solving, and cognitive flexibility. They explained this effect with cognitive interference. This means that attentional processes are interrupted when two concurrent activities compete for the same amount of limited cognitive resources (Armstrong & Greenberg, 1990; Armstrong, Boiarsky, & Mares, 1991). It is, thus, not surprising that several studies have shown that media use while engaging in study-related tasks is related to lower

As a result of these cognitive costs related to media multitasking, the ability to resist media distractions is an important skill for children and adults alike. It is thus crucial to understand which individual characteristics determine whether people engage in task switching or whether they are able to resist the media distractions they are confronted with. However, our understanding of individual differences in this process is still limited. Although several studies have identified age as an important predictor (Carrier, Cheever, Rosen, Benitez, & Chang, 2009; Rideout, Foehr, & Roberts, 2010; Rosen et al., 2013; Voorveld & van der Goot, 2013), multitasking behavior of children has rarely been studied. In the present study, we will further investigate age differences by comparing computer-based multitasking of children and adults.

Moreover, previous research has identified several audience factors that determine media multitasking. In addition to impulsivity (Sanbonmatsu, Strayer, Medeiros-Ward, & Watson, 2013) and sensation seeking (Duff, Yoon, Wang, & Anghelcev, 2014; Jeong & Fishbein, 2007), studies have consistently shown that media multitasking is related to attentional processes (Ophir, Nass, & Wagner, 2009; Ralph, Thomson, Cheyne, & Smilek, 2013). Findings of these studies suggest that heavy media multitaskers have poorer attentional control, and thus have trouble focusing their attention (Ophir et al., 2009). In the present study we further examine how this specific audience factor, i.e., attentional problems, may influence computer-based multitasking. Additionally, we will investigate potential interactions between age and attention problems which have not been previously examined.

Age differences in computer-based multitasking

Young people are often referred to as the main media multitaskers (Rideout et al., 2010) and, for the new generation, media multitasking is assumed to be the “new normal” (Courage et al., p. 6). Most studies on media multitasking, however, focus on samples with one specific age range (i.e., young adults). Only few studies have compared different age groups (Brasel & Gips, 2011; Carrier et al., 2009; Rosen et al., 2013; Voorveld & van der Goot, 2013), and none of these studies included children under the age of 13. Using media diaries, Voorveld and van der Goot (2013) found that adolescents (aged 13 to 16) engaged in media multitasking more frequently than older age groups (17–65 years). Similarly, Carrier et al. (2009) reported that members of the Net generation (which they defined as university students aged up to 29 years) multitasked with media more frequently than older age groups. When observing gaze switches between two separate devices, a computer screen and a TV screen, Brasel and Gips (2011) found that young adults (aged 18–22) switched more frequently than older adults (aged 28–65). However, not all studies found reliable age differences. For instance, Rosen et al. (2013) reported that middle school, high school, and university students did not differ in their usage of media while studying. Overall, these studies indicate that adolescents and young adults are the main media multitaskers in comparison to older adults.

To date, only one study has investigated media multitasking among children aged 8–12 (Pea et al., 2012). However, this study used only self-reports of media multitasking and did not compare the amount of children’s media multitasking behavior to older individuals. It remains unknown how susceptible children are to engage in media multitasking in comparison to adults. For these reasons, the current observational study will specifically
investigate how children differ from adults in a situation that allows for computer-based multitasking.

Several explanations may account for potential age differences in media multitasking between children and adults. First, the emotionally gratifying nature of media distractions may be more difficult to resist for children because they are less able to delay gratifications (Steinberg et al., 2009). Research has shown that the ability to delay gratifications increases with age (Green, Fry, & Myerson, 1994). It may, therefore, be more difficult for children to resist tempting media distractions when engaging in a boring or strenuous task.

Second, children may still lack important executive functions to be able to focus their attention on one task. Executive functions comprise several cognitive control processes that are responsible for controlling attentional processes, inhibiting behavior, and planning (e.g., Brocki & Bohlin, 2004; Welsh, Pennington, & Groisser, 1991). These control processes still develop during childhood and adolescence (Huizinga et al., 2006). Children may consequently have more difficulties than adults controlling their attention in order to persevere on one task. They may be more easily distracted and less able to inhibit their switching behavior. In line with this reasoning, Baumgartner, Weeda, van der Heijden, and Huizinga (2014) have shown that adolescents who report problems with their executive functions indeed engaged in media multitasking more frequently. The protracted development of executive functions may thus explain why children may have a lower attention span than adults.

Finally, previous literature based on the Uses and Gratifications framework has shown that one of the motives for internet multitasking is the avoidance of boredom (Hwang, Kim, & Jeon, 2014). Moreover, it has been shown that sensation seeking is related to media multitasking (Jeong & Fishbein, 2007). As children may become bored more easily, and have higher levels of sensation seeking, they may be more likely to engage in computer-based multitasking in comparison to adults in order to fulfill their developmental needs.

Based on this reasoning we pose the following hypothesis:

**H1:** When engaging in a computer task, children spend less time on the main activity overall, they switch earlier to other computer activities, and switch more frequently between different computer activities.

**Attention problems as predictors of computer-based multitasking**

All of the above arguments explain why children may have more difficulties than adults to focus their attention on a single task. However, next to these age differences, there may also be individual differences in the ability to focus attention. Resisting media distractions may be particularly difficult for individuals, children, and adults, who suffer from attention problems. Individuals with attention problems have difficulties focusing on tasks for longer periods of time, and are more easily distracted (Cantwell, 1996). In the presence of media distractors, individuals with attention problems may find it more difficult to sustain their attention on the main activity. Several previous studies have linked attention problems to media multitasking frequency (Ralph et al., 2013; Sanbonmatsu et al., 2013).

Furthermore, it has been shown that attention problems are related to higher levels of boredom when engaging in a boring task (Malkovsky, Merrifield, Goldberg, & Danckert, 2012). Since boredom avoidance is one motive for engaging in media multitasking (Hwang et al., 2014), it may be expected that individuals with attention problems who experience
boredom sooner than individuals without attention problems may be more motivated to engage in media multitasking.

Overall, findings from previous studies indicate that individuals who suffer from attention problems may find it more difficult to focus their attention on one specific activity without being distracted by other media activities. However, all studies were based on self-reports of attention problems and media multitasking. It may thus be that the observed relationship between disposition and media multitasking was due to common method variance. It remains unclear whether these effects reflect real-life behavior and can be replicated when observational data are used rather than self-reports.

Based on previous research, we pose the following hypothesis:

\[ H2: \text{When engaging in a computer task, individuals with more attention problems spend less time on the main activity overall, they switch earlier to other computer activities, and switch more frequently between different computer activities.} \]

Interaction effects between age and attention problems on computer-based multitasking

Age and attention problems have been previously postulated as main factors in predicting media multitasking. However, in addition to these main effects, there may also be potential interaction effects between the two factors. Attention problems are not unique to children or adolescents. Although in many cases, these dispositional differences persist into adulthood (Faraone, Biederman, & Mick, 2006; Spencer, Biederman, & Mick, 2007), the behavioral manifestations of attention problems may differ in adulthood in comparison to childhood. Moreover, while attention problems may still be present in adults, they may have fewer effects on their life (Frazier, Youngstrom, Glutting, & Watkins, 2007). During the course of development, individuals may learn how to adapt to their attention problems. Although they may still experience attention problems, they may have found strategies to cope with them more efficiently. Adults with attention problems may have improved their ability to focus their attention because they have learned that this may have advantages, for example in a work-related context. Moreover, adults who suffer from attention problems may have a better awareness of these problems and may thus counteract their need for cognitive stimulation. For instance, even in situations that require sustained attention for longer periods of time, they may be aware of their urge to lose attention and may compensate this with extra effort. Thus, due to socialization and development, adults with attention problems may have learned to control their attention more efficiently than children with attention problems (Faraone et al., 2006; Gawrilow, Merkt, Goossens-Merkt, Bodenburg, & Wendt, 2011).

In the context of media multitasking, this may indicate that children with attention problems may be more easily distracted by other media activities than adults with these same problems. However, since previous studies have investigated the effects of attention problems on media multitasking solely among adolescents and young adults (Ralph et al., 2013; Sanbonmatsu et al., 2013), it is yet unclear whether attention problems and age interact in explaining computer-based multitasking. We, therefore, pose the following research question:

\[ RQ1: \text{Are the effects of attention problems on task switching stronger for children than for adults?} \]
The current study

The aim of the present study was to investigate the developmental and dispositional determinants of computer-based multitasking. More specifically, we wanted to investigate the effects of age and attention problems on the likelihood to switch between tasks when engaging in a main activity on the computer. To this end, an observational study was conducted among a large sample of children and adults. We focused on computer-based multitasking because this is a frequently occurring form of multitasking and may reflect typical study- or work-related situations for both age groups. We examined how long children and adults focused on a main activity, and how often they switched between tasks when other media distractors were present.

Method

Sample

Data were collected at a science museum in Amsterdam, the Netherlands, during three weeks in July 2014. The science museum provides lab spaces to researchers who want to conduct their studies among a large and diverse sample of museum visitors. Museum visitors were addressed by the researchers and student assistants for participation. As part of a larger project on media multitasking, two separate studies were conducted during these three weeks.

In total, 361 people participated in the observation study. Eleven participants had to be removed due to either missing observational or self-report data. In addition, 26 participants were removed because of either missing age information (n = 3), because they were younger than six years old (n = 3), or because they were between 14 and 17 years old (n = 20).

The final sample consisted of 164 children and 160 adults. The child sample consisted of 80 boys and 84 girls (51%). The age of the children ranged from 6 to 13 years (M = 9.14, SD = 1.97). Most children still attended primary school (81%). Approximately half of the children lived in urban areas (53.6%), the rest in rural areas. The adult sample consisted of 65 men and 95 women (59%). The age range of the adults was 18–75 years (M = 41.88, SD = 13.97). Sixty-six percent of the adults lived in urban areas, and 40% had a university degree or higher.

Procedure

Participants were seated in front of a computer. A maximum of four participants could participate at any given moment. Computers were placed in the lab in a way that participants did not disturb each other. Participants were told that the aim of the study was to test how a computer training could improve specific cognitive abilities (cover story). They were told that they had 10 minutes to train their cognitive skills on the computer (main task) and that afterwards their cognitive abilities would be tested. Participants received the instruction that they should ideally train for the complete 10 minutes to increase their performance on the subsequent testing task. However, whenever they felt that they had trained enough or needed a short break in between, they could also engage in any of three other tasks (distractor tasks) on the computer. All tasks were briefly introduced to the participants.
Four tabs were shown on the screen, similar to a regular web browsing session. On the first tab, the main task was displayed. The aim of the main task was to find and click on all hearts and dollar signs that were displayed among a variety of other signs, numbers, and icons on the screen as fast as possible. When a heart or dollar sign was correctly identified, the color of these icons changed from white to green (on a blue background). When all 20 hearts and dollar signs were identified, a new session started, again consisting of 20 hearts and dollar signs that had to be found. We chose for this task for several reasons. First, it was simple enough so that even young children could understand and play it easily. At the same time, it was still challenging for adults. Second, the task was relatively easy to perform but it required cognitive effort to sustain attention for a 10-minute period, sharing attributes of a typical learning or homework situation. Participants were encouraged to train as much as possible in the allotted time and to perform the task as well as possible.

The other three browser tabs could be used to switch to one of the distractor tasks. On the second tab, participants could play a memory game. The third tab displayed a cartoon video, and the fourth tab presented news items. The tasks were programmed in Presentation® which automatically recorded all switching behavior on the computer.

After engaging in these tasks for 10 min, participants filled out a short online survey. Questions were read aloud to all children who needed help reading. Afterwards, participants undertook the supposed test task (i.e., simplified version of an Eriksen Flankers task). Parents of child participants also completed brief reports about their children’s attention problems. In the end, all participants were debriefed. Children received a certificate for participation. In total, the study took approximately 20 min to complete.

**Measures**

**Computer-based multitasking**
Participants’ computer-based multitasking was automatically registered. The following indicators of computer-based multitasking were used: (1) total amount of time spent with the main activity (including time on main activity when resuming after a switch to another activity), (2) initial time spent on the main task before a first switch occurred, and (3) total number of switches between tasks. The first two indicators were recorded in milliseconds and subsequently transferred into minutes. Means and standard deviations of these measures can be found in the results section.

**Attention problems**
Attention problems were measured with three items from the “Inattentive presentation” dimension from the DSM-5 criteria for ADHD (APA, 2013). The short form used in the current study is based on other so-called ADHD Symptom Rating Scales which have been successfully used in earlier studies (e.g., DuPaul, Power, McGoe, Ikeda, & Anastopoulos, 1998; Pelham, Gnagy, Greenslade, & Milich, 1992; Pelham, Fabiano, & Massetti, 2005). These studies created rating scales that were based on the criteria for ADHD set in the most recent edition of the DSM, which were used either as a self-report or other-report of inattention. The three items we used were nearly identical to those used in previous studies and still reflective of the latest edition of the DSM. The items were: “I am easily distracted,” “I have difficulties sustaining attention on a task,” and “I am easily distracted when I have to listen for longer time periods.”
Respondents indicated on a five-point scale, ranging from 1 (never) to 5 (very often), how often specific situations happened to them. The answers to these three questions were averaged. Adults filled in these questions for themselves, $M = 2.81$, $SD = 0.76$, Cronbach’s alpha = .87. For the children, parent reports of attention problems were used, $M = 2.85$, $SD = 0.95$, Cronbach’s alpha = .91. Parent reports were available for 132 children. Only these were included in the regression analyses below. All other analyses are based on the full sample.

Because attention problems were measured based on self-reports for the adult sample, and parent reports for the child sample, we tested for the metric invariance of the two measures. If the metric invariance can be established, this indicates that the latent construct of attention problems has the same meaning for the child as well as the adult sample (Kühne, 2013). To establish metric invariance, a multigroup confirmatory factor analysis was conducted in which the factor loadings were constrained to be equal among the two age groups. A chi-square difference test indicated that the two models did not differ significantly from each other ($p = .53$). This indicates that the factor loadings are equal across the two samples and that metric invariance applies. This finding supports the idea that the two types of measures have the same meaning and can be compared in further analyses.

**Additional measures**

To further assess individual differences in computer-based multitasking, we included two additional indicators, namely task performance and task relevance. Task performance on the main task was measured by recording the time that participants needed to finish the main task for the first time (i.e., time needed until they had found all heart and dollar signs), $M = 54.06$ s, $SD = 34.45$. Moreover, as a second indicator of task performance, we assessed the amount of mistakes participants made on the main task when engaging in it for the first time (i.e., how often they accidentally clicked on other signs).

In addition, task relevance was assessed by examining liking of and motivation to engage in the main task. Participants were asked how much they liked the main task on a scale from 1 (not at all) to 5 (very much). The mean for liking the main task was $M = 3.64$, $SD = 0.92$. As an indicator for the motivation to perform well on the main task, participants were asked how important they found it to practice with this task on a scale ranging from 1 (not important at all) to 5 (very important). The mean for this indicator was $M = 2.93$, $SD = 1.04$.

**Results**

**Descriptive findings**

On average, participants engaged in the main task for 5.46 (SD = 3.19) out of 10 minutes. Participants initially stayed on the main task on average for 4.22 min (SD = 3.43) before switching to another activity. The average amount of task switches was 3.97 (SD = 3.99). Only 12% of the child participants did not switch at all, and engaged in the main task for the whole 10 minutes. In comparison, 29% of the adults did not switch at all. Twenty percent of the children spent less than one minute on the main task before their first switch, and 49% less than two minutes. Of the adults, 13% spent less than one minute and 32% less than two minutes on the main activity before the first switch. Children liked the main task significantly
more ($M = 3.95, SD = 0.84$) than adults ($M = 3.39, SD = 0.87$), $t(314.41) = 5.86$, 95% CI $[0.37; 0.75]$, $p < .001$. Children also indicated that they found it more important to perform well on the main task ($M = 3.13, SD = 0.99$) than adults ($M = 2.71, SD = 1.04$), $t(322) = 3.74$, 95% CI $[0.42; 0.11]$, $p < .001$. Correlations between all main variables can be found in Table 1.

### Age differences in computer-based multitasking

To examine Hypothesis 1, three $t$-tests were conducted. As assumed in Hypothesis 1, children spent less time with the main task in total ($M = 4.75, SD = 3.05$) than adults ($M = 6.18, SD = 3.18$), $t(322) = −4.13$, 95% CI $[−2.11; −0.75]$, $p < .001$. Moreover, they spent less time on the main activity before their first switch ($M = 3.39, SD = 5.09$) than adults ($M = 5.09, SD = 3.60$), $t(310.11) = −4.58$, 95% CI $[−2.42; −0.97]$, $p < .001$. In addition, children switched more frequently between tasks ($M = 4.63, SD = 4.20$) than adults ($M = 3.29, SD = 3.67$), $t(322) = 3.06$, 95% CI $[0.48; 2.20]$, $p = .002$. These findings support Hypothesis 1.

### Dispositional differences in computer-based multitasking

Hypothesis 2 stated that individuals who exhibit more attention problems are more likely to engage in computer-based multitasking. To test this hypothesis, three multiple regression analyses were conducted with age and attention problems as independent variables, and each of the three multitasking indicators as dependent variables. The regressions did not reveal any significant effects of attention problems on any of the three dependent variables, above the effect of age (see Table 2). These findings, therefore, do not support Hypothesis 2.

### Table 1. Correlations between main variables.

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Age</td>
<td></td>
<td>−.09</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Attention problems</td>
<td>−.28***</td>
<td>−.10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Time before first switch</td>
<td></td>
<td>−.05</td>
<td></td>
<td>−.63***</td>
</tr>
<tr>
<td>4. Total time on first task</td>
<td>.21***</td>
<td></td>
<td>.84***</td>
<td></td>
</tr>
<tr>
<td>5. Amount of switches</td>
<td>−.22***</td>
<td>.09</td>
<td>−.43***</td>
<td></td>
</tr>
</tbody>
</table>

Notes: Correlations including attention problems are based on $n = 292$ (due to missing parent reports of attention problems for children). All other correlations are based on the whole sample ($N = 324$).

***$p < .001$.

### Table 2. Results of regression analyses with attention problems as predictor.

<table>
<thead>
<tr>
<th>Predictors</th>
<th>Outcome: computer-based multitasking</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Time before first switch (in min)</td>
</tr>
<tr>
<td></td>
<td>$B$ (SE)</td>
</tr>
<tr>
<td>Constant</td>
<td>4.59 (0.72)</td>
</tr>
<tr>
<td>Age (1 = adult)</td>
<td>1.65 (0.39)</td>
</tr>
<tr>
<td>Attention problems</td>
<td>−0.41 (0.23)</td>
</tr>
<tr>
<td>Adjusted $R^2$</td>
<td>.06</td>
</tr>
</tbody>
</table>

Note: Based on $n = 292$. More ($M = 3.95, SD = 0.84$) than adults ($M = 3.39, SD = 0.87$), $t(314.41) = 5.86$, 95% CI $[0.37; 0.75]$, $p < .001$. Children also indicated that they found it more important to perform well on the main task ($M = 3.13, SD = 0.99$) than adults ($M = 2.71, SD = 1.04$), $t(322) = 3.74$, 95% CI $[0.42; 0.11]$, $p < .001$. Correlations between all main variables can be found in Table 1.

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Interaction effects between age and attention problems

To investigate potential interaction effects between age and attention problems (RQ1), three multiple regression analyses were conducted with a dummy variable for the age groups (0 = children, 1 = adults), attention problems (centered), and an interaction term between age and attention problems as independent variables. Collinearity statistics indicated that there were no issues with multicollinearity (tolerance values at least above .59, VIFs below 1.79). The three multitasking indicators were included as dependent variables. For all three dependent variables, all independent variables were significant (see Table 3 for all estimates). Interestingly, the interaction terms between age and attention problems were significant for all three regression analyses. To interpret the interactions, they were visualized using simple slope techniques (Dawson, 2014). As can be seen in Figures 1–3, this indicates that the effects of attention problems on computer-based multitasking were stronger for children than for adults. Thus, particularly children with attention problems had difficulties to focus their attention on the main task without switching.

Figure 1. Interaction between age and attention problems on time spent on first task before first switch (in minutes).

Table 3. Results of regression analyses including interaction term attention and age.

<table>
<thead>
<tr>
<th>Predictors</th>
<th>Outcome: Computer-based multitasking</th>
<th>Time before first switch (in min)</th>
<th>Total time main task (in min)</th>
<th>Amount of switches</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>$B$  (SE) $\beta$  $p$</td>
<td>$B$  (SE) $\beta$  $p$</td>
<td>$B$  (SE) $\beta$  $p$</td>
</tr>
<tr>
<td>Constant</td>
<td></td>
<td>3.44  (0.29) .000</td>
<td>4.70  (0.27) .000</td>
<td>4.25  (0.34) .000</td>
</tr>
<tr>
<td>Age (1 = adult)</td>
<td></td>
<td>1.65  (0.39) .24</td>
<td>1.49  (0.36) .23</td>
<td>−0.97  (0.44) −.13</td>
</tr>
<tr>
<td>Attention problems</td>
<td></td>
<td>−0.96  (0.31) −.24</td>
<td>−0.93  (0.28) −.24</td>
<td>1.03  (0.35) .23</td>
</tr>
<tr>
<td>Attention × age</td>
<td></td>
<td>1.24  (0.46) .20</td>
<td>1.58  (0.43) .28</td>
<td>−1.45  (0.52) −.21</td>
</tr>
<tr>
<td>Adjusted $R^2$</td>
<td></td>
<td>.08 .09</td>
<td>.08 .09</td>
<td></td>
</tr>
</tbody>
</table>

Notes: Attention × Age = Interaction term attention problems by age. $n = 292$. 

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Additional analyses

To further examine potential developmental patterns, we conducted two additional sets of analyses. First, we conducted the multiple regression analyses again but treated age as a continuous independent variable. In these analyses, the full sample was included (also including the 20 adolescents so that age could be treated as a continuous variable). The time spent on the main task before the first switch, total time spent on the main task, and the total amount of switches were again included as separate dependent variables. These regression analyses revealed the same pattern as before. For all three regressions, age was negatively related to computer-based multitasking (all $p < .001$), attention problems were positively related to computer-based multitasking (all $p < .05$), and a significant interaction term was found for age and attention problems (for total time spent on main task, and time before first switch $p < .05$; for amount of switches, $p = .08$). Figure 4 presents a scatterplot of the

Figure 2. Interaction between age and attention problems on total time spent on first task (in minutes).

Figure 3. Interaction between age and attention problems on amount of task switches.
total number of switches according to age to further visualize age differences in computer-based multitasking.

Second, we were interested in whether there were different developmental patterns within the two age groups. We conducted several correlations to compare the relationships between age and the three dependent computer-based multitasking variables separately for each age group. These correlations revealed that within the child sample (6–13 years), there were no significant correlations between age and multitasking (all \( p_s \geq .10 \)), indicating that there were no developmental differences among the children; smaller children switched equally often than older children. However, a decrease in multitasking could be revealed among the adult sample (18–75 years), with computer-based multitasking being negatively related to age. Older adults spent more time on the main task before their first switch, \( r = .21, \ p = .006 \), and switched significantly less often, \( r = -.24, \ p = .002 \). No correlation was found for age and the total time spent on the first task, \( r = .09, \ p = .27 \).

To further examine whether perceived liking of the main task and motivation to perform well was related to computer-based multitasking, we conducted a series of correlations. Motivation was not related to any of the three multitasking variables, neither for the children (all \( p_s > .64 \)), nor for the adults (all \( p_s > .26 \)). However, liking of the task was related to multitasking for two of the measures in the child sample (time on main task before first switch: \( r = .17, \ p = .03 \); total time on main task: \( r = .22, \ p = .01 \), and for the amount of total switches in the adult sample (\( r = -.18, \ p = .02 \)), indicating that children who liked the task more engaged in it longer.

Finally, we conducted additional correlations to examine whether computer-based multitasking was related to an individual’s perception that the main task was either too simple or too difficult. The time needed to complete the first task and the amount of mistakes made in the first task were the two indicators for performance on the main task. For the children, the time needed to finish the first task was positively related to the time on the main task before first switch, \( r = .17, \ p = .02 \), but not to any of the other multitasking indicators. The number of mistakes on the main task was not related to any of the switching indicators. This
suggests that for children, how well they performed on the main task did not change their switching behavior.

For the adults, the time needed to finish the first task was related to all three multitasking indicators (time on main task before first switch: \( r = .26, p = .001 \); total time on main task: \( r = .24, p = .003 \); total switches: \( r = -.21, p = .008 \)). The amount of mistakes was not related to any computer-based multitasking indicator. Overall, this indicates that adults who spent more time finishing the first task, switched less frequently. This could be due to adults’ perception that they did not perform well enough and that they needed to practice more, or to the fact that they had less time left after finishing the first task to switch to the other tasks.

Discussion

When working on school- or work-related tasks, children as well as adults nowadays face an environment that is full of media distractions. This is particularly so when working on devices that provide many functions, such as computers, laptops, and smartphones. Maintaining focus while working on these devices may require more effort because emotionally gratifying media distractors are easily accessible. The present study observed computer-based multitasking among a diverse sample of children and adults. Overall, the findings indicate that individuals find it indeed difficult to focus on a main activity for 10 minutes in the presence of appealing media distractors. Although participants indicated that they liked engaging in the main activity, 80 percent of participants did not stay on the main task for the full ten minutes but switched to other media content in between (88% of the children, and 71% of the adults). Almost half of the children and one third of the adults stayed less than two minutes on the main activity before switching to other media content. This indicates that it seems difficult for children as well as for adults to focus attention on an activity when other media distractors are present.

Moreover, the results of the present study show that children were more easily distracted than adults. Children spent less time on the main activity, and switched more frequently between tabs on a computer. However, these age differences between children and adults were qualified by an interaction effect between age and attention problems. This finding indicates that the relationship between attention problems and computer-based multitasking was stronger for children than for adults. Children with attention problems engaged more frequently in computer-based multitasking in comparison to children without attention problems. This finding suggests that, in particular, children with attention problems may be vulnerable to media distractions.

The present study is the first to show that attention problems may interact with age to explain computer-based media multitasking. Attention problems seemed to predict media multitasking particularly for children. Although some argue that attention problems continue to affect adults’ daily lives (Spencer et al., 2007), the current study seems to suggest that they are able to resist media distractors better than children with attention problems. It might be that due to experience and practice, they learned to cope with media distractions in their day-to-day lives. For example, Gawrilow et al. (2011) showed that adults with and without ADHD did not differ in their performance in a laboratory multitasking task but that adults with ADHD underestimated their performance and felt more stressed when exposed to the task. Moreover, adults with ADHD showed the best performance and mood in a well-structured task in comparison to the unstructured multitasking situation. Linked to the present
study, this could indicate that adults with attention problems learned over the course of their development that their performance and mood is worse in multitasking situations. To overcompensate their deficits they may avoid multitasking. Similarly, other researchers have found evidence that among adults with ADHD, the effects of ADHD on their academic achievement decreased with age (Frazier et al., 2007). Also this finding may be interpreted in terms of a compensation effect for adults with ADHD who may learn how to compensate their deficits.

The present study provides a first indication that even individuals with attention problems might learn to ignore media distractions as they grow older. However, the present findings could also be based on generational instead of developmental differences. Many older adults in this sample may neither be as computer savvy nor as interested in computer activities as children. For children with attention problems, the presented computer activities might have been more appealing and, therefore, more difficult to resist. Moreover, it could be that the present tasks were less meaningful for the adults in this study in comparison to the children. Thus, it might be that adults with attention problems may be equally distracted when presented with media content that is of more relevance for them. Future studies are needed to investigate age differences in multitasking in a variety of settings that take into consideration the personal relevance of the offered distractors.

Further analyses among the two samples indicated that although there were no age differences in the frequency of computer-based multitasking among the child sample, in the adult sample, older adults were less likely to engage in computer-based multitasking than younger adults. This finding may again point towards generational differences with older people being less used to computer-based multitasking than younger generations. Previous research has shown that the ability to multitask decreases with age (Reimers & Maylor, 2005; Todorov, Del Missier, & Mäntylä, 2014). These studies indicate that older adults have more difficulties to resume a task when switching to other tasks in between. It might be that a lower ability to multitask may result in older adults preferring to remain on one task instead of multitasking.

In contrast to findings relying on self-reports of media multitasking (Ralph et al., 2013), we found that adults with attention problems were not more easily distracted by media than adults without attention problems. Two explanations may account for these differences. First, the finding by Ralph et al. (2013) may be due to common method-variance, using self-reports for both attention and media multitasking. Second, it may still be that adults with attention problems are more likely to engage in media multitasking in their everyday lives. Media multitasking in the Ralph et al. (2013) study was measured with the Media Multitasking Index (Ophir et al., 2009) which assesses the simultaneous use of a wide range of media. Our study only investigated computer-based multitasking in a very specific setting. It may be that adults with attention problems were able to control their attention for ten minutes in our study but may still tend to media multitask more frequently in their leisure time. To further understand the influence of attention problems on media multitasking in adults, it may be necessary to observe behavior for longer periods of time.

Interestingly, children indicated that they liked the main task more, and that they were more motivated to perform well than adults. Nevertheless, children with attention problems were more easily distracted. Although they liked the main activity, they seemed to be less able to resist other tempting media content. Children suffering from attention problems may be most vulnerable to the omnipresence of media in today’s world. These children need
more help to focus their attention when media distractors are present. Parents might be advised to help their children by restricting media access during times when children have to focus, such as doing their homework. Moreover, children at an early age should be instructed how to practice their skills to ignore irrelevant media distractors. This might be done by informing children about specific cognitive costs of switching (e.g., task takes longer, memory deficits, etc.) and by trying to separate media time from school-related work time (Carrier et al., 2015). When children (in particular those who already have problems to focus their attention) have to work on a computer for school-related tasks, it may help them to temporarily block other content from these devices.

For the children in this study, there was no relationship between computer-based multitasking and their motivation or actual performance on the main task. There was, however, a negative relationship between computer-based multitasking and liking of the main task. Whereas the motivation to perform well on a task may be a cognitive decision, liking of the main task can be considered as an emotional judgment. This finding indicates that cognitive appeals to children that a task is important may be less beneficial to prevent multitasking than producing tasks that are appealing to children. For the adults, neither liking nor motivation was linked to multitasking whereas performance on the main task was. This may indicate that adults are more goal-oriented and that their performance is a better predictor of multitasking than whether they enjoy the main task that they are working on. Adults advanced metacognitive skills may allow them to reflect on their performance. They may thus put more effort in not becoming distracted by media even when working on a boring task.

The present study highlights the importance of individual differences in explaining media multitasking. The findings show that not all children were equally distracted by media. These individual differences may also play a role in explaining media multitasking effects. Recent media effect models postulate that specific determinants of media use also function as moderators in explaining media effects (Valkenburg & Peter, 2013). According to these models, children with attention problems who are particularly prone to engage in media multitasking may also be more vulnerable to potential media multitasking effects over time. If children with attention problems experience gratifying emotional states when multitasking, this may trigger the urge to multitask in similar situations. Over time, these children may learn that emotional gratifications are inherent to media multitasking and may be less able to resist media distractions. In the long-run, this might increase their attention problems.

Limitations and suggestions for future research

One main shortcoming of the present study is that measures of attention problems differed for adults and children. While adults filled in self-reports, we used parent reports for children’s attention problems. We chose for this approach because young children have limited abilities for introspection and to evaluate their own behavior (Becker, Hagenberg, Roessner, Wöerner, & Rothenberger, 2004; Flavell, Green, & Flavell, 2000). Although measurement invariance between the two measures could be established, future studies may profit from using multi-method approaches to assess attention problems for both children and adults.

In the present study, we investigated multitasking in only one specific setting (i.e., computer-based multitasking). To further investigate age differences in multitasking, task characteristics should be systematically varied in future studies. For example, based on
previously defined multitasking dimensions (see for example, Wang, Irwin, Cooper, & Srivastava, 2015), the tasks could vary in terms of cognitive effort, task relevance, emotionality, or time pressure. In addition, future studies may want to vary the length of the task. The present multitasking situation was only 10 minutes long. It may be that age differences or effects of attention problems may have a stronger influence during longer experimental settings. Moreover, when interested in age differences, the social relevance of the distractor tasks may also be of importance. Many media distractors today are social media-based, which seem to be particularly appealing for younger people. As the peer group becomes increasingly important during adolescence (Steinberg & Morris, 2001), it may be expected that adolescents are particularly sensitive to socially relevant media distractors. Identifying media distractors that are particularly hard to resist for specific age groups, may help to target interventions to these specific age groups. For example, if we know that children and adolescents are particularly distracted by socially relevant stimuli, it may help to show them strategies to cope with these specific media distractors.

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Notes on contributors

Susanne E. Baumgartner (PhD) is an assistant professor at the Amsterdam School of Communication Research, University of Amsterdam. Her main research focuses on the consequences of media multitasking for the cognitive and emotional development of adolescents.

Sindy R. Sumter (PhD) is an assistant professor at the Amsterdam School of Communication Research, University of Amsterdam. Her research focuses on the link between youth’s online experiences and their social and emotional development.

ORCID

Sindy R. Sumter https://orcid.org/0000-0002-8542-0148

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