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Measuring Media Multitasking

Development of a Short Measure of Media Multitasking for Adolescents

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Abstract: Although media multitasking is an increasingly occurring form of media use, there are currently no validated, short instruments to measure media multitasking among adolescents. The aim of the present study, therefore, was to develop a short media multitasking measure for adolescents (MMM-S). Two studies with a total sample of 2,278 adolescents were conducted. The findings of these studies suggest that the MMM-S is a useful, reliable, and valid measure to assess media multitasking among adolescents. The findings indicate that the concurrent validity of the short measure is equal to that of a more extensive measure. Because of its high utility, the MMM-S may provide an alternative for existing extensive measures of media multitasking.

Keywords: media multitasking, short measure, adolescents

Media multitasking – the simultaneous use of two or more media – is an increasingly occurring form of media use (Foehr, 2006; Moreno et al., 2012; SPOT, 2010), in particular among adolescents (SPOT, 2012). The rise in media multitasking is mainly driven by mobile technologies that allow adolescents to use media wherever and whenever they want. Because of its high prevalence among adolescents, it is important to understand the predictors and consequences of media multitasking for youth (Wallis, 2010). There is cumulative evidence that media multitasking is negatively related to a variety of cognitive and socio-emotional consequences for adolescents and young adults (Alzahabi & Becker, 2013; Baumgartner, Weeda, van der Heijden, & Huizinga, 2014; Becker, Alzahabi, & Hopwood, 2013; Lui & Wong, 2012; Ophir, Nass, & Wagner, 2009; Pea et al., 2012). For example, it has been shown that media multitasking is related to lower academic performance, and lower social connectedness among adolescents (Junco & Cotten, 2012; Pea et al., 2012).

Investigating media multitasking among adolescents is not only important because young people are the main media multitaskers, but also because they may be particularly vulnerable to its effects. In comparison to adults, adolescents may find it more difficult to focus their attention in the presence of media distractions. Despite increasing

research interests in the causes and consequences of media multitasking among adolescents, there are currently no validated instruments to measure media multitasking among adolescents.

The most widely used measure to date is the media multitasking index (MMI) developed by Ophir et al. (2009). The MMI assesses a variety of different media multitasking combinations, thereby providing an account of the overall level of media multitasking during media time. Although it has been successfully used in previous research among adults, the MMI has several disadvantages for its use among younger people which are discussed in the following section. Other studies that did not use the MMI assessed either very specific media multitasking combinations (e.g., using Facebook, or instant messaging while studying; Bowman, Levine, Waite, & Gendron, 2010; Collins et al., 2004; Junco & Cotten, 2012; Levine, Waite, & Bowman, 2007), or applied single item measures (Collins et al., 2004; Duff, Yoon, Wang, & Anghelcev, 2014).

The main aim of the present study, therefore, was to develop a short measure of media multitasking that provides an equally valid and reliable estimate of media multitasking as extensive measures of media multitasking.

Challenges of Existing Media Multitasking Measures

Since its development in 2009, the MMI (Ophir et al., 2009) has been used in a variety of studies (Alzahabi & Becker, 2013; Becker et al., 2013; Lui & Wong, 2012; Pea et al., 2012; Ralph, Thomson, Cheyne, & Smilek, 2014; Sanbonmatsu, Strayer, Medeiros-Ward, & Watson, 2013), and has quickly become the standard measure of media multitasking. The MMI was the first measure that assesses media multitasking in its full extent and has made a great contribution to the field. The original MMI (Ophir et al., 2009) assesses the total number of hours per week someone spends with 12 forms of media. For each of these 12 media forms, participants subsequently indicate how often they concurrently use each of the other 11 media forms. This results in 132 media multitasking combinations. For each of these items, respondents indicated their level of engagement on a 4-point scale with the following response categories: *never* (0), *a little of the time* (.33), *some of the time* (.67), and *most of the time* (1).

To calculate the MMI, these responses are summed for each primary medium. This summed score is subsequently weighted according to the total time spent with the primary medium. These scores are summed across all primary media categories and divided by the total amount of media use. The equation of the MMI is as follows:

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

With m_i indicating the summed amount of secondary media use while using a specific primary medium i ; h_i the estimated amount of time spent with a specific primary medium i ; and h_{total} the estimated total amount of primary media use (across all primary media) (see Ophir et al., 2009).

The MMI poses several challenges to researchers, in particular to those who are interested in media multitasking among adolescent samples. The first practical problem of the MMI concerns its length. The MMI measures media multitasking by assessing 132 media multitasking activities. The advantage of this approach is that it is very exhaustive. However, assessing such large amounts of media multitasking activities has several disadvantages. One main disadvantage is that it is very strenuous for participants, in particular when additional concepts are assessed in a questionnaire. Moreover, the length of the measure may cause errors due to “increased participant fatigue [. . .], low motivation, high dropout, and poor response quality” (Konrath, Meier, & Bushman, 2014). These problems may be particularly relevant when examining adolescents. Adolescent participants may have less motivation, and a lower

attention span than adult participants (Borgers, de Leeuw, & Hox, 2000). Moreover, children and young adolescents are also oftentimes slower readers and it may take them even more time to answer the questionnaire (Borgers et al., 2000).

Another disadvantage of the MMI for its use among adolescents is that its distribution is heavily skewed to the left (Pea et al., 2012). Because previous studies using media diaries or observations (Rideout et al., 2010; Rosen, Carrier, & Cheever, 2013; SPOT, 2010) have shown that media multitasking is highly prevalent among adolescents, the skewness of the MMI may not adequately reflect the distribution of media multitasking among adolescent samples, but may rather reflect a measurement issue. This skewness is partly due to the fact that some multitasking combinations that are assessed with the MMI only rarely occur in adolescents’ everyday life (e.g., reading while gaming, or reading while calling someone on the phone). By assessing many media multitasking combinations that occur only rarely among adolescents, media multitasking as measured with the MMI is likely underestimated among adolescent samples.

The MMI has at least two more challenges, which are not particularly related to its use among adolescent samples but that researchers need to take into account when using the MMI. The first challenge concerns the interpretation of the values of the MMI. Although the calculation of the MMI is the same across studies, the interpretation of what the value means differs among researchers. In the original article, Ophir et al. (2009) state that the MMI “is an indication of the level of media multitasking the participant is engaged in during a typical media-consumption hour” (p. 15586). Similarly, Alzahabi and Becker (2013) conclude: “The Media Multitasking Index (MMI) indicates the average amount of media multitasking that is occurring during a typical hour of media usage” (p. 1495, appendix). In contrast, Pea et al., (2012), state that “the MMI is a count of the number of additional media an individual is using when using a medium” (p. 330). Most other studies that used the MMI simply refrain from interpreting the values (Lui & Wong, 2012; Sanbonmatsu et al., 2013).

These differences in interpreting the values of the MMI originate from the difficulty in identifying the unit of the MMI. For example, someone indicates that s/he spends 10 hours per week watching TV. Moreover, this person indicates that s/he spends most of the TV time listening to music, and some of the TV time using the internet. Following the MMI equation above, this person receives a MMI value of: $(1 + 0.67) \times 10 / 10 = 1.67$. This value indicates the proportion of secondary media use in reference to total media use. A value of 1.67 therefore means that someone uses on average 1.67 media concurrently with watching TV.

Due to the rather arbitrary assignment of values to the response categories (e.g., .67 for “some of the time”), and the summing of all responses, the values of the MMI may, however, not realistically reflect the level of multitasking. For example, the mean MMI in the Ophir et al. (2009) study was 4.38. This value, however, suggests that 4.38 media are used concurrently with a primary media during an average media hour. It is rather unlikely that this is a realistic estimation of the absolute amount of media multitasking. The MMI may thus give an indication of the general level of media multitasking, but interpreting it in terms of the count of additional media used with a primary media may be misleading.

A final problem concerning the interpretation of the MMI relates to the total amount of media use. The MMI score is based on relative (not general) use of media and cannot be interpreted in terms of absolute use. Thus, the score does not allow determining the actual time spent media multitasking. A value of 1, for example, indicates that someone uses on average one other medium concurrently with the primary medium, no matter whether this person uses the primary medium for 1 or 10 hours. Therefore, the MMI cannot be interpreted in terms of hours spent multitasking.

Developing a Short Measure of Media Multitasking

The main aim of the present article is to develop a valid and reliable scale of media multitasking that is of high utility for assessing media multitasking among adolescents. More specifically, the measure should be short, and comprehensive, its distribution should be normal, and the values should be easily interpretable. To develop a short measure, it may be sufficient to only assess the most prevalent media multitasking combinations. In particular among adolescents, media multitasking typically revolves around social media, such as social network sites and instant messaging. Due to their interruptive nature, these applications have been previously called “multitasking facilitators” (Pea et al., 2012). Previous research has shown that these activities are typically used simultaneously with other media or non-media activities, such as watching TV or doing homework (Bowman et al., 2010; Levine et al., 2007). Instead of assessing all possible media multitasking combinations, it may be sufficient to focus only on *typical* media multitasking activities that best reflect the concept of media multitasking. This may decrease the skewness and the length of the measure. For example, media multitasking combinations such as reading a book while gaming may not frequently occur and are therefore not representative of the concept of media multitasking. By assessing many media multitasking activities that hardly occur in

reality, the original MMI artificially increases the skewness of the distribution of the media multitasking measurement. Therefore, the first aim of this study is to identify a subsample of media multitasking activities that best represent the concept of media multitasking and to test whether this smaller sample can be utilized to measure adolescents’ media multitasking equally well as more exhaustive measures.

Comparing Two Scoring Techniques

The MMI weights media multitasking based on general media use. This is advantageous because if general media use is neglected, it is not clear whether possible effects are caused by media multitasking or media use in general. However, this requires adolescents to make very specific estimates of their media use in hours per day or week. However, accurate estimations of media use are difficult, in particular for younger people (Vandewater & Lee, 2009). Difficulties in estimating the amount of media use time are even more apparent for mobile media applications that are used very frequently throughout the day but only for very short moments, such as checking Facebook updates, or sending text messages (Boase & Ling, 2013; Vandewater & Lee, 2009). Therefore, weighting media multitasking based on general media use may lead to additional estimation errors.

Another possibility is to simply assess media multitasking on a rating scale. For example, Baumgartner et al. (2014) assessed media multitasking frequency on a scale from 1 (= *never*) to 4 (= *very often*). Similarly, Collins (2008) assessed media multitasking on a scale from 1 (= *never*) to 4 (= *often*). Across several media multitasking combinations, this score is averaged providing an average media multitasking frequency score. These types of measures provide an indication of the general tendency to engage in media multitasking but not about the *absolute* time spent multitasking, nor are they weighted based on time spent with media. However, to account for time spent on media, general media use can be added in the analysis as a control variable (see for example Baumgartner et al., 2014). The advantage of this approach is that providing answers on these rating scales is much easier for the respondents, and that estimation errors for media use do not interfere with the media multitasking measure. Moreover, these measures have clear minimum and maximum values that increase their interpretability.

These two approaches, the MMI and the rating scales, have never been directly compared. Thus, it is unknown which measure of media multitasking is better, to what degree the estimates of these approaches differ, and how the different measures are related to different outcome variables. The present studies compare these approaches

to establish whether it is necessary to weight media multitasking based on media use or whether it is sufficient to assess the general amount of media multitasking.

The Current Studies

Two studies with a total sample of 2,278 adolescents were conducted. Study 1 included a two-wave longitudinal study which aimed at 1) developing a short measure of media multitasking derived from an extensive measure; 2) comparing the two different scoring techniques; 3) comparing the different versions of the measure based on their correlations and concurrent validity, and finally 4) examining the test-retest reliability of the measures. The aim of Study 2 was to validate the short measure among a larger and more diverse sample of adolescents.

Study 1

Study 1 was a two-wave longitudinal study with a 1-year time lapse among 523 adolescents. The data reported here is part of a larger study on the development of goal-directed behavior in adolescents (see Baumgartner et al., 2014). To create a short measure based on an extensive item pool, a subsample of items was selected. The selection criteria for the items of the short measure were as follows: the short measure should be 1) highly correlated with the long measure, 2) normally distributed, and 3) correlated with theoretically related concepts (concurrent validity). Both versions, the long and short measure, were calculated in two different ways; the first follows the approach by Ophir et al., (2009) by weighting the measure based on general media use. In the second approach, rating scales were used and average scores calculated.

In order to determine the concurrent validity of the measures, the short and long measures were compared by examining their relationship to different outcome measures. Several previous studies have found a negative relationship between media multitasking and cognitive control (Cain & Mitroff, 2011; Ophir et al., 2009). Our previous research has shown that media multitasking is related to problems in executive function (Baumgartner et al., 2014). Executive functions are cognitive control processes that are responsible for effectively guiding behavior and cognition (Gioia, Isquith, Kenworthy, & Barton, 2002; Huizinga & Smits, 2011). More specifically, we found significant relations between media multitasking and three subdomains of executive function, namely working memory, inhibition, and shifting (Baumgartner et al.,

2014). To compare the concurrent validity of the short and long measures we, therefore, chose to use these three concepts as measures for concurrent validity.

Moreover, media multitasking has also been related to age, with older adolescents being more likely to multitask than younger adolescents (SPOT, 2010), and girls being somewhat more likely to engage in media multitasking (Foehr, 2006). Thus, the concurrent validity of both the long and short version of the measure is established by assessing the relationship between the media multitasking measures and age, gender, and executive function.

Finally, the test-retest reliability was assessed by correlating the measures across the two time points. Because the two measurement points were one year apart, we expected media multitasking to be moderately stable over time, similar to previous stability assessments of general media use (Lee, Hornik, & Hennessy, 2008).

Method

Sample and Procedure

Respondents in the first wave were 523 adolescents (aged 11 to 15; $M_{\text{age}} = 13.09$, $SD_{\text{age}} = 0.85$; 48.2% girls) from six urban and suburban high schools in the Netherlands. Of these, 419 (80%) also participated in the second wave one year later ($M_{\text{age}} = 14.14$, $SD = 0.76$, 48.4% girls). At both time points, participants filled in an online survey in class, which took approximately 45 minutes.

Measures

Media Use

To measure total media use, participants indicated for the nine media activities (see below), how long they used each media type on an average day. Response categories ranged from 1 (*not at all*) to 6 (*3 hours or more*).

Media Multitasking Measure - Long version (MMM-L)

The original measure was based on the multitasking index used by Pea et al. (2012) and Ophir et al. (2009). To use the measure among adolescents, we adapted the measure slightly by reducing the media activities that were assessed from 12 to 9 (resulting in a total item reduction from 132 to 72 items). We focused on the nine most popular media activities among adolescents:

- (1) watching TV,
- (2) reading,
- (3) listening to music,
- (4) talking on the phone,
- (5) sending messages via phone or computer (e.g., text messages, Ping, WhatsApp, Instant messaging),
- (6) using social network sites (e.g., Facebook, Twitter),
- (7) watching movies on the computer,

- (8) other computer activities (e.g., surfing on the web, photoshop, etc.), and
 (9) playing video games.

In contrast to Ophir et al.'s (2009) original measure, we combined sending messages via phone or computer because the distinction between both becomes increasingly blurred due to new technological developments that cannot easily be categorized as either text messaging or instant messaging (e.g., WhatsApp). Moreover, we combined emailing, surfing, and other computer activities into one item; we excluded listening to audio other than music, and added social network site use because of its popularity among adolescents.

Following the approach of Ophir et al. (2009), for each of these nine media activities, participants indicated on a four-point scale how frequently they engage in the specific media activity simultaneously with each of the other eight activities. The response categories were: 1 (= *never*), 2 (= *sometimes*), 3 (= *often*), and 4 (= *very often*). For example, participants were asked, "While watching TV, how often do you use *social network sites* at the same time" and "While watching TV, how often do you *send messages via phone or computer* at the same time". For each of the nine media activities, an average score for media multitasking with the eight other media activities was created; resulting in nine media multitasking subscales. Each of these nine subscales represented a multitasking index for a primary activity (e.g., watching TV) and the eight other media activities as secondary activity. The nine media multitasking subscales correlated highly with each other (all correlations: $r > .50$, $p < .01$). To create an overall media multitasking index, the average of all multitasking items was calculated (MMM-L). This media multitasking index indicates the relative amount of media multitasking across different media categories. See Table 1 for means and standard deviations.

Additional Measures

To measure the concurrent validity of the scale, additional constructs were assessed. From the behavioral rating inventory of executive function (Gioia et al., 2002; Huizinga & Smits, 2011), the subscales *working memory*, *inhibition*, and *shifting* were used. Working memory reflects the ability to keep information in mind for use at a later time point. It is also typically used as a measure of the ability to concentrate. Working memory was measured with 11 items ($M = 1.58$, $SD = 0.37$, Cronbach's alpha = .83). Inhibition measures the ability to inhibit inappropriate behavior, and was measured with 12 items ($M = 1.54$, $SD = 0.35$, Cronbach's alpha = .84). Shifting measures the capacity to efficiently shift between tasks (Miyake et al., 2000). Shifting was measured with seven items ($M = 1.42$, $SD = 0.33$,

Table 1. Means and Standard Deviations for the Media Multitasking Measures for both Studies

	Mean	Standard Deviation
MMM-S, w1	2.22	0.77
MMM-S, w2	2.25	0.73
MMM-L, w1	1.71	0.52
MMM-L, w2	1.68	0.48
MMI-S, w1	0.96	0.66
MMI-L, w1	2.03	1.43
MMM-S, Study 2	2.27	0.71

Notes. MMM-S = media multitasking measure short, MMM-L = media multitasking measure long, MMI-S = media multitasking index short, MMI-L = media multitasking index long, w1 = Wave 1, w2 = Wave 2.

Cronbach's alpha = .72). Participants rated the items on a scale from 1 (= *never*) to 3 (= *often*). Higher values indicate more problems with working memory, inhibition, and shifting.

Results

Item Selection for the Short Media Multitasking Measure, MMM-S

To increase the utility of the scale, the initial 72 items were reduced to 9 items. The selection of these items was based on the three most prevalent items of the three most prevalent subscales. We chose this approach because of the positive skewness of the initial 72 items (skewness = 1.41). Some of the media multitasking combinations that were initially assessed had very low prevalences, indicating that adolescents do not frequently engage in these media multitasking combinations. The most prevalent subscales were media multitasking with TV, sending messages, listening to music and social network sites. Because listening to music is mainly a background activity that does not require full attention, we only used this as secondary activity but not as primary activity. From each of the remaining three subscales, we used the three most prevalent combinations. Table 2 displays the nine final items.

To calculate the short media multitasking measure (MMM-S), these nine items were averaged into one mean index ($M = 2.21$, $SD = 0.77$, Cronbach's alpha = .90). In contrast to the long measure, the short measure was almost normally distributed (skewness = 0.41). Although the MMM-S consists of only a small amount of items, it was highly correlated with the MMM-L, $r = .82$, $p < .001$. This strong correlation between the short and long measure provides an indication that it is possible to assess this concept with less than 72 items.

Calculating the MMI

The MMM-S and MMM-L are based on estimations of the frequency of media multitasking independent of general

Table 2. List of items of the Short Media Multitasking Measure for Adolescents (MMM-S)

1. While watching TV, how often do you engage in the following activities...
...listening to music
...sending messages via phone or computer
...using social networking sites
2. While using social network sites, how often do you engage in the following activities...
...listening to music
...sending messages via phone or computer
...watching TV
3. While sending messages via phone or computer, how often do you engage in the following activities...
...listening to music
...using social networking sites
...watching TV

Note. Participants rate each of the nine items on a scale from 1 (= never) to 4 (= very often).

amount of media use. To take media use into account, we followed Ophir et al.'s (2009) approach for both the long and the short version (see equation above). For the long version all items were taken into consideration (MMI-L). For the short version only the nine items as displayed in Table 2 were used (MMI-S). The resulting means for the MMI-L (72 items) and for the short version MMI-S (9 items) were $M = .96$ ($SD = 0.66$), and $M = 2.03$ ($SD = 1.43$), respectively. Similar to the MMM-L, the distribution of the MMI-L was skewed (skewness = 1.24), whereas the MMI-S was approximately normally distributed (skewness = 0.60). The MMI-L/MMI-S and the MMM-L/MMM-S correlated almost perfectly with each other, $r = .98/.99$, $p < .001$ (see Table 3). The mean of the MMI-L in our study was substantially smaller than the mean of the MMI in the original study (Ophir et al., 2009). This difference may be due to differences in age, and country of origin of the samples used in Ophir et al.'s (2009) and our study.

Comparing Concurrent Validity

To determine and compare the concurrent validity of the four measures, they were correlated with theoretically related concepts. Both, the short and the long versions of the MMI and the MMM were related to negative behavioral aspects of executive function (see Table 3 for all correlations). Adolescents who multitask more frequently reported more problems with their working memory, inhibiting inappropriate behavior, and shifting between different tasks. Working memory capacity and inhibition were equally related to both measures of media multitasking. Shifting showed only weak correlations to the long measures. In the case of the MMM-S and MMM-L, the correlations remained highly significant when controlling for the frequency of media use (partial correlations MMM-S with inhibition and working memory: $r = .15$, $p = .001$, $r = .19$,

Table 3. Correlations between Media Multitasking Measures Study 1, Wave 1.

	MMM-S	MMM-L	MMI-S	MMI-L
MMM-L	.82***	–	–	–
MMI-S	.98***	.79***	–	–
MMI-L	.84***	.99***	.82***	–
Age	.11*	.06	.11*	.07
Gender	.21***	.05	.22***	.07
Media Use	.69***	.65***	.67***	.65***
Inhibition	.26***	.23***	.27***	.23***
Working memory	.22***	.20***	.23***	.21***
Shifting	.07	.12**	.07	.12**

Notes. * $p < .05$, ** $p < .01$, *** $p < .001$. MMM-S = media multitasking measure short, MMM-L = media multitasking measure long, MMI-S = media multitasking index short, MMI-L = media multitasking index long.

$p < .001$ / partial correlations MMM-L with inhibition, working memory, and shifting: $r = .12$, $p < .01$, $r = .17$, $p < .001$, $r = .13$, $p < .01$).

The MMM-S and MMI-S were weakly correlated with age, with older adolescents and girls being somewhat more likely to engage in media multitasking. In contrast, the MMM-L and MMI-L were not related to gender or age. As expected, all four measures were moderately related to media use (see Table 3). This indicates that media multitasking is related to the amount of media someone uses, but it represents a unique concept.

Test-Retest Reliability

Wave 2 of the study was used to measure the test-retest reliability of the scale. The means for the MMM-L and MMM-S in Wave 2 were comparable to Wave 1 (see Table 1). The MMM-L and MMM-S from Wave 1 correlated moderately with the respective measures in Wave 2 (MMM-L: $r = .52$, $p < .001$; MMM-S: $r = .57$, $p < .001$). This indicates that media multitasking is relatively stable over time.

Study 2

The aim of Study 2 was to validate the MMM-S in a second, independent sample. Because the sample in Study 1 was limited to 11 to 15 year old adolescents, in Study 2, the MMM-S was tested with a broader age range, ranging from 11 to 18 years of age. To further assess the concurrent validity of the short measure, its correlation to age, gender, and impulsivity was assessed in this sample. Previous research has shown that media multitasking is related to higher levels of impulsivity (Minear, Brasher, McCurdy, Lewis, & Younggren, 2013; Sanbonmatsu et al., 2013). We therefore expected that the MMM-S was related to higher levels of impulsive behavior.

Method

Sample and Procedure

Respondents in Study 2, were 1,755 Dutch adolescents aged 11 to 18 ($M_{\text{age}} = 13.82$, $SD_{\text{age}} = 1.44$, 47% female). Participants were recruited from seven schools in the Netherlands. Participants filled in the questionnaire during school hours.

Measures

MMM-S

The nine items of the MMM-S as described above were collected in this study. Participants indicated how frequently they engage in each of the nine multitasking activities, ranging from 1 (= *never*) to 4 (= *very often*). The average of the nine items was taken as an indicator of media multitasking frequency.

Media Use

Frequency of TV use, social media use, and text messaging was assessed by asking participants how much time they spent per day with these media. The answer options were 1 (= *not at all*), 2 (= *less than 30 minutes*), 3 (= *30 minutes to 1 hour*), 4 (= *1 to 2 hours*), 5 (= *2 to 3 hours*), 6 (= *3 to 4 hours*), 7 (= *4 to 5 hours*), 8 (= *more than 5 hours*). Answers on these questions were averaged to receive an overall media use value ($M = 3.67$, $SD = 1.37$).

Impulsivity

Impulsivity was assessed with four items from the Barratt Impulsivity Scale (BIS) (Patton, Stanford, & Barratt, 1995) ($M = 2.81$, $SD = 0.73$, Cronbach's alpha = .66).

Results Study 2

The mean and standard deviation of the MMM-S in this sample were highly comparable to the ones found in Study 1 ($M = 2.27$, $SD = 0.71$). The MMM-S was normally distributed (skewness = 0.20) and showed high internal consistency, Cronbach's alpha = .88. Similar to the findings in Study 1, the MMM-S was positively related to gender ($r = .25$, $p < .001$), age ($r = .15$, $p < .001$), and media use ($r = .72$, $p < .001$). The MMM-S was also moderately positively related to impulsivity, $r = .20$, $p < .001$. Overall the findings suggest that the prevalence and findings from the first sample are generalizable to other adolescent samples and that the MMM-S can be used among adolescents aged 11 to 18. Moreover, Study 2 supported the concurrent validity of the MMM-S.

Discussion

The main aim of the current paper was to develop the first short media multitasking measure for adolescents.

In addition, we compared the short measure to extensive measures of media multitasking, and assessed its validity. The findings suggest that the MMM-S is a useful, reliable and valid measure to assess media multitasking among adolescents. The findings indicate that the concurrent validity of the short measure is equal to that of a long measure of media multitasking. Moreover, the short measure is approximately normally distributed among adolescent samples. Due to its brevity it can be easily applied in survey studies among adolescents. Because of its high utility it may provide an alternative for existing extensive measures of media multitasking.

The MMM-S only focusses on the combinations between four different types of media: TV, music, social network sites, and instant messaging. Nevertheless, the MMM-S is highly correlated with the MMM-L that assesses a wide range of media multitasking combinations, and is equally well related to other theoretically linked concepts. This indicates that it may be sufficient to assess media multitasking with the short version. Focusing on the most prevalent multitasking activities may be sufficient to assess overall media multitasking behavior among youth. Moreover, focusing on the most prevalent media multitasking activities has the advantage that the measure is less skewed. Media multitasking while gaming, reading, or calling on the phone are less prevalent and may only be engaged in by a few adolescents.

Both versions, the MMM-S and the MMM-L correlated similarly with executive functions. This indicates that adolescents who engage more frequently in media multitasking report a variety of everyday problems in these domains of executive functioning. Moreover, these adolescents show elevated levels of impulsivity. This is in line with an increasing number of studies showing that media multitasking is related to problems in cognitive control processes (Cain & Mitroff, 2011; Ophir et al., 2009; Ralph et al., 2014). Together with an increasing amount of studies on the potential cognitive and socio-emotional consequences of media multitasking, the present findings underline the importance of this type of media use for adolescent development. The MMM-S may be used in a wide range of studies that investigate the causes and consequences of media multitasking.

There were a few differences between the MMM-S and the MMM-L. First, the observed means of the MMM-S were larger than those of the MMM-L. Because of the skewness of the distribution of the MMM-L among adolescent samples, the MMM-S focusses on the most prevalent media multitasking combinations to provide a more accurate reflection of media multitasking among adolescents. A second difference between the two measures is that the short scale correlated with age and gender, whereas the long version did not. This difference may be based on the fact that

the MMM-S has a stronger focus on social media multitasking, which is particularly prevalent among girls and older adolescents. The finding that older adolescents and girls were somewhat more likely to multitask is in line with previous research (Foehr, 2006; Rideout, Foehr, & Roberts, 2010; SPOT, 2012). The MMM-L assesses several multitasking behaviors that are mainly engaged in by boys, such as multitasking while gaming. This may explain why there are no gender differences in the MMM-L. However, despite these gender differences, both measures were highly correlated with each other and similarly correlated to other constructs.

Another slight difference is that shifting was only significantly related to the MMM-L. However, the difference in the correlations was small ($r = .07$ vs. $r = .12$) and both correlations were weak. More research is needed to investigate if, and which types of media multitasking are related to shifting ability.

The MMM-S assesses each media multitasking combination twice, with each media activity being both the primary and the secondary activity (e.g., watching TV while sending messages vs. sending messages while watching TV). This is in line with how media multitasking was assessed in previous studies (see all studies using the MMI, e.g., Ophir et al. 2009; Pea et al., 2012). In our studies, the items assessing a medium as primary or secondary activity correlated only moderately. This may indicate that individuals distinguish between primary and secondary media activity and that it is necessary to assess both combinations.

Weighting Media Multitasking Based on Media Use

A second aim of this study was to compare different approaches of measuring media multitasking by taking general amount of media use into account. Surprisingly, the present findings suggest that both approaches are highly comparable. Although the calculations are different, the two types of measures were almost perfectly correlated. This may indicate that when judging their overall amount of media multitasking, adolescents implicitly take the estimation of general media use into account. Respondents may rely on heuristics when judging their media multitasking behavior, similar to when judging their media use. Thus they may implicitly estimate media multitasking based on general amount of media use. For example, someone who watches a lot of TV may take this into account when rating the amount of media multitasking while watching TV, whereas someone who hardly watches TV may estimate low levels of TV multitasking.

Estimating the general amount of media use (e.g., in minutes per day) is very difficult, in particular with mobile media technologies. Recent studies have shown that

estimations of mobile phone use are highly underestimated (Boase & Ling, 2013). Because the two measures (MMM-L and MMI-L) were highly comparable, it may be sufficient to assess the frequency of media multitasking on a rating scale without asking for general media use estimations.

Implications for Research: Which Measure to Choose?

The present studies provide some tentative suggestions for researchers to find an adequate measure of media multitasking. If researchers want to assess media multitasking alongside a variety of other measures to assess its predictors, consequences, or correlates, the MMM-S may be the measure of choice. The MMM-S assesses the relative tendency of engaging in media multitasking among adolescent samples. It is short, easy to apply, and has equally good properties than more extensive measures.

However, if researchers are interested in assessing the effects of different media multitasking combinations, it is recommended that researchers choose a more extensive measure, such as the MMM-L or the MMI-L. It may be that specific media multitasking combinations have a stronger impact on adolescent development than others. In this case, the MMM-S may not be sufficient and a more extensive measure should be chosen.

If researchers are interested in absolute amounts of media multitasking (e.g., hours per week spent media multitasking), other measures of media multitasking may be necessary. One possible solution could be media diaries (Voorveld & van der Goot, 2013). However, media diaries are strenuous for participants and difficult to employ among large samples of adolescents. A better and more objective method may be the use of automatic tracking software (Yeykelis, Cummings, & Reeves, 2014). This approach has not yet been used frequently but may provide a strong alternative for future studies.

Limitations and Implications for Future Studies

The present studies were conducted among large samples of adolescents in the Netherlands. The Netherlands is a highly technologically-oriented country with high use of internet and social media among youth (Spot, 2012). To further assess the cross-cultural validity of the MMM-S, it is necessary to test it in other countries. The media multitasking measures reported in this paper rely on self-reports. To what extent these self-reports reflect true media multitasking behavior needs to be assessed in future studies. Observational studies are needed that validate the accuracy of self-reports.

The MMM-S has four response categories, similar to those used for the MMI (Ophir et al., 2009). However, it is arguable whether it is adequate to treat measures with these types of response categories as ratio level measures. To check whether the treatment of these variables as interval-level variables influenced the results, we double-checked the correlations (as depicted in Table 3) using non-parametric Spearman's rank correlations. These additional analyses were highly comparable to the correlations resulting from parametric Pearson correlation¹. We therefore feel confident that treating these measures as interval-level instead of ordinal-level variables did not influence the results substantially. Future studies may compare different response categories of the MMM-S (e.g., 5- or 7-point Likert scales) to find the most adequate response categories.

The MMM-S is a measure of media multitasking designed specifically for adolescents. Media multitasking may take very different forms for different age groups (Voorveld & van der Goot, 2013). The media multitasking combinations assessed with the MMM-S are particularly relevant for younger media users. However, although not tested in this study, we assume that the MMM-S may be equally suited for young adults (e.g., student samples). Adolescents and young adults are similar in their use of social media and smartphones, which are the main media multitasking facilitators. It may therefore be assumed that the MMM-S is also applicable for young adults. Further studies are needed, however, to examine the validity of the measure among adult samples.

Conclusion

In our media-saturated world, it becomes increasingly important to understand how youth use media. Measuring media multitasking adequately, however, poses challenges to researchers. The present paper compared different approaches of measuring media multitasking among adolescents. The findings indicate that measuring media multitasking with a short measure may be equally valid as assessing media multitasking with extensive measures. Weighting media multitasking based on absolute media use frequency (as done in previous studies) may not be necessary because the correlations between both approaches are very high.

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¹ These analyses can be obtained from the first author.

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