

On a meta-level: Contributions of meta-analytic summaries in media psychological research

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The facts are always friendly,
every bit of evidence one can acquire, in any area,
leads one that much closer to what is true.

Carl Rogers

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Abstract

The rising use of new media has given rise to public discussions about their possible negative consequences. The social sciences have answered these concerns, providing many studies investigating different media types (e.g., social media, video games) and different related variables (e.g., psychological well-being, academic achievement). Within this big body of research, some research results have confirmed negative associations with frequent media use; other studies have found no or even positive relationships. With heterogeneous results, it is difficult to obtain a clear picture of the relationships and causalities of new media. The method of meta-analysis allows a synthesis of all existing data, providing an overall effect size as well as moderator and mediator analyses which might explain the heterogeneity.

Three manuscripts present meta-analytic evidence related to a) the relationship between social media use and academic achievement, b) the relationship between video gaming and overweight, and c) the relationship between social media and psychological correlates. Manuscript #1 found small relationships which depend on the usage pattern of social media. The relationship is positive, as long as social media use is related to school. Manuscript #2 showed that children's and adolescents' video gaming is independent from their body mass, while adults who play more have a higher body mass. Manuscript #3 summarized existing meta-analytic evidence that links social media with psychological wellbeing, academic achievement, and narcissism with small to moderate effect sizes. All three manuscripts underscore the potential of meta-analyses to synthesize previous research and to identify moderators. Although meta-analyses are not necessarily superior to other approaches because of their limitations (e.g. limited information or quality of primary studies) they are very promising for media psychology. Meta-analyses can reduce complexity and might be helpful for the communication of research results to the general public.

Zusammenfassung

Die Entwicklung neuer Medien wurde von öffentlichen Debatten über mögliche negative Folgen begleitet. Wissenschaftler*innen reagierten auf diese Bedenken mit einer Vielzahl von Studien und untersuchten mögliche Effekte verschiedener Medientypen (z. B. soziale Medien, Videospiele) auf verschiedene Variablen (z. B. psychologisches Wohlbefinden, akademische Leistungen). Während manche Forschungsergebnisse die diskutierten negativen Zusammenhänge häufiger Mediennutzung bestätigten, fanden andere Studien jedoch keine oder sogar positive Zusammenhänge. Die Forschungslage zu medienpsychologischen Fragestellungen zeigt oft heterogene Ergebnisse, die keine abschließenden Aussagen erlauben. Eine Lösung für dieses Problem ist die Methode der Meta-Analyse. Hierbei werden alle vorhandenen Studien zusammengefasst und ein Gesamteffekt berechnet. Darüber hinaus können Moderator- und Mediatoranalysen durchgeführt werden, die die Heterogenität zwischen den Studien erklären könnten. In drei Manuskripten wurden a) die Beziehung zwischen Social Media-Nutzung und akademischen Leistungen, b) die Beziehung zwischen Videospiele und Übergewicht und c) die Beziehung zwischen sozialen Medien und psychologischen Korrelaten meta-analytisch untersucht. In Manuskript Nr. 1 zeigte sich, dass der Zusammenhang zwischen sozialen Medien und akademischer Leistung von der Art der Nutzung abhing. Der Zusammenhang war positiv, solange die Nutzung sozialer Medien akademischen Zwecken diente. Manuskript 2 zeigte, dass das Körpergewicht von Kindern und Jugendlichen nicht in Verbindung mit der Videospielenutzung stand, während Erwachsene, die mehr spielten, eine höhere Körpermasse hatten. Manuskript Nr. 3 fasste meta-analytische Studien mit gleichen Fragestellungen zu sozialen Medien und psychologischen Variablen (Wohlbefinden, akademische Leistung, Narzissmus) zusammen.

Alle drei Manuskripte unterstreichen das Potenzial von Metaanalysen, den existierenden Forschungsstand zusammenzufassen und Moderatorvariablen zu identifizieren. Obwohl Meta-Analysen aufgrund ihrer Einschränkungen (z. B. die begrenzte Anzahl und Qualität von Primärstudien) anderen Methoden nicht unbedingt überlegen sind, sind sie dennoch für medienpsychologische Fragestellungen sehr vielversprechend. Metaanalysen sind in der Lage die Komplexität des Forschungsstands zu reduzieren und könnten für die Kommunikation von Forschungsergebnissen an die breite Öffentlichkeit hilfreich sein.

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1 Introduction

In the last decades, the development of new media and digital technologies has shaped the everyday lives of most people, especially in industrialized countries (Internet World Stats, 2018). The internet offers many new possibilities to connect with others over long distances (e.g., e-mail, online social network sites) or to seek information (e.g., search engines such as Google or Ecosia). Digital technology aims to simplify our lives (Manning-Schaffel, 2017), work environment (McDonald & Roswell-Jones, 2012), and the consumer world. Entertainment technology promises more exciting experiences, with better video games, movies, and music (Fitzpatrick et al., 2016; Hall, 2018; Power, 2018). More and more people use social media, play (online) video games, and find information online.

With every new medium, questions are raised on the possible consequences of its use. Often, negative outcomes are expected and disseminated easily through social media. For example, Schleuser (2015) discussed the declining use of proper grammar, shorter attention spans, and less social time. However, most questions on possible media threats are not easily answered. The amount and the usage patterns of new media vary, and general statements cannot depict complex relationships. Therefore, controversial opinions exist, and digital threats are discussed by different interest groups (e.g., laypersons, parents, teachers, journalists, celebrities, and scientists). These discussions are often mediated by new media: in online blogs (e.g., Araújo, 2018; Rocha, 2016; Trimble, n.d.), YouTube videos (e.g., Persin, 2015 with 56 million views and 61,000 comments; Bavelier, 2012 with over 4 million views and 13,527 comments), and online media reports (e.g., Filucci, 2017; Nair, 2013). Additionally, there is a social perception of being in a post-truth era characterized by “fake news” and growing insecurity (Enfield, 2017). This uncertainty underscores the need for clear answers on effects of media, in terms of their effect direction and their impact.

Media effects might be problematic, for example when social media use reduces self-esteem in young adults (e.g., Ahadzadeh, Sharif, & Ong, 2017; Fardouly, Willburger, & Vartanian, 2018), but they can also be beneficial, e.g. for learning English as a foreign language using YouTube and online gaming (e.g., Alwehaibi, 2015; Hsu, 2015). Further, the amount of influence new media has in everyday life should be noted. The question is not only whether there are effects, and whether they are positive or negative, but also regarding the size of these effects. Moreover, processes behind these effects are often not clear. For example, the association between violent video gaming and aggression depends on an individual's moral disengagement (Teng et al., 2019). We need a clearer picture of how media effects occur to foster a general understanding of media effects. However, when it is hard to evaluate the credibility of information or of its source, some public theories – especially the ones that foster fears – might be easier to believe, because there is a lack of scientific evidence (Tannenbaum et al., 2015).

This emphasizes the need for an understanding of possible media influences. The most reliable way to achieve this is to conduct empirical research. In the last decades, scientists have contributed diligently to the public discourse (e.g., on the relationship between violent video gaming and aggressive behavior, Calvert et al., 2017). The purpose of science is to find reliable answers. Movements such as the “March for Science” (March For Science New York City, n.d.) underline the importance of scientific knowledge for society. Some topics have already been widely researched, but the results of the studies may still be inconclusive. Even for scientists, the amount of heterogeneous studies is challenging. At this point, a synthesis of all empirical evidence on one research question is needed, not only to find out what the overall effect is, but also to identify factors that lead to the different findings in the first place. This scientific method has a name: *meta-analysis*. Meta-analytic evidence provides an evaluation of the whole research body of a certain field. It is superior to single studies, which

are limited to specific samples, research designs, and methods. Meta-analyses are of high value for public discussion because they include all published evidence and have therefore far more weight and higher credibility than anecdotal evidence. Briefly, meta-analyses enable researchers to approach the true effect and support the general public in judging certain issues.

1.1 New media – A new danger?

Innovations often result in fears. In the 19th century, people believed in a brain illness caused by fast railway journeys (Seher, 2017). Books were assumed to be highly dangerous for the mental health of women (North, 2014). In the 20th century, microwaves and cell phones were supposedly able to fry our brains (Arthur, 1998). Moreover, today, people fear that humanity is becoming antisocial because of excessive smartphone use. While the fears of the past centuries have proved unnecessary, the threat media poses today is being questioned and discussed (see Figure 1). New and unknown things are often intimidating and may



Figure 1. Men reading newspapers in the early 20th century versus today's "smartphone zombies" (Weird History, 2014)

lead to uncertainty, which can develop into fear (i.e., neophobia; Nugent, 2013). It is not surprising that such fears have also been triggered by many new technologies introduced over the last decades of digitalization (Manjoo, 2017).

1.1.1 Digital threats in popular literature

Scholars send warning messages especially to parents to protect their children. Books about digital threats have been flooding the book market (especially in Germany). These books have titles such as *Digital Dementia*, a bestseller in Germany (buchreport.de, n.d.), *Smartphone Epidemic*, *Digital Burnout*, or *Digital Depression* (Diefenbach & Ullrich, 2016; Markowitz, 2015; Spitzer, 2012, 2019). The alarming titles are attracting more and more

interest. These popular books tell us how often we use our smart phones – on average 55 times (in total three hours) per day – and what consequences can be expected (mostly negative) (Markowetz, 2015). For every digital behavior, a possible addiction is discussed (e.g., Alter, 2017; te Wildt, 2015). Some authors assume that social comparison has become more frequent through social media and instead of enjoying their lives, people are becoming *digitally depressed* (Diefenbach & Ullrich, 2016). Authors such as Susan Greenfield or Manfred Spitzer claim that computer games or online chats affect the brain structure. Accordingly, new media rewire the brain and influence, for example, individuals' empathy and identity (Greenfield, 2015). New media may even reduce the brain mass of children, leading to attention and motor deficits, stress, depression, and aggressiveness (Spitzer, 2012, 2015). Often-cited author Nicholas Carr further discusses *what the internet is doing to our brains* (Carr, 2011). The digital threats presented in popular literature (e.g., Carr, 2011; Spitzer, 2012) might give the impression that the internet, social networks, and mobile phones are responsible for all the bad happening to an entire generation. These anticipated “problems” are even mirrored in names given to this generation: *digital natives*, *iGeneration*, *generation me*. The names describe a generation that is *permanently online and connected* (Vorderer, Krömer, & Schneider, 2016). The book *iGen* describes today's teens and adults as a generation completely born into the digital era and why this causes so many problems (Twenge, 2017).

1.1.2 Research findings in public discussions on media threats

Yet, how dangerous is digital media really? In addition to the above described popular books, empirical research also deals with questions concerning media use. Especially the disciplines of communication and media science as well as communication and media psychology investigate antecedents, processes, and consequences of media use. This research does not only focus on effects of media use (in the sense of a simple stimulus-response

assumption), but tries to explain the mechanisms underlying the correlations and media effects. To support the threats described in their publications, the authors of popular literature cite empirical studies, but sometimes (and maybe unintentionally) cherry-pick only the studies supporting their claims or focus only one side of the heterogeneous study base. Most empirical relationships and causalities are complex and multi-determined. Research results are therefore often ambiguous and difficult to grasp, especially for people working in other fields. This is highly relevant because politicians may not have their background in media research but are the decision makers when it comes to the introduction of new laws. To include scientific results more accurately in the public discourse, it is important to understand how laypersons perceive and process scientific information.

1.1.3 The research question

At this point, it is necessary to mention the rather obvious threats of internet use. Data security is one of the major topics that affects every user. Contacts between minors and sexual offenders as well as cyber mobbing or sexting may happen more easily, and children and adolescents should be made aware of this threat. Threats of this kind should not be underestimated, but they are not the focus of this dissertation.

The questions this dissertation addresses are the possible digital threats of new media that are controversially discussed by the general public. Based on such discussions, decisions are made by parents (e.g., media ban for their children) or politicians (e.g., legal media ban). Such decisions should not be based on prejudices, biased selections of empirical studies, or misinterpreted research results (e.g., causal implications of correlations). In this context, research's mission is to elucidate complex relationships and to assist decision-makers. When studies report different findings and when personal stories are more important than statistics from research reports, how can science contribute to a clearer picture of anticipated media threats? Meta-analytic summaries might help when complex issues have been investigated in

many single studies, making it harder to communicate the overall conclusions. The method of meta-analyses could be the best method to present empirical research and will therefore be the focus of this dissertation.

1.2 Meta-analytic summaries for complex questions

Against a background of heterogeneous research findings, meta-analytic summaries are helpful, providing research reports with more weight than single studies, which may have to be replicated to generate reliable information. A meta-analysis summarizes previous research on a certain question. As the name indicates, meta-analyses allow for conclusions at the meta-level. By taking a step out of the ocean of single studies, an overview is possible which offers the opportunity to assemble a clearer picture of a certain topic. Using statistical methods, the findings have a quantitative value. Such a quantification of the whole study base facilitates the interpretation of relationships and pathways. The results of a meta-analytic summary of research on media effects can therefore make a suitable contribution to public discussions on this topic.

1.2.1 Advantages of meta-analyses

For empirical research, meta-analyses provide many advantages over single studies, even beyond systematic reviews. A meta-analysis not only summarizes the results from single studies like systematic reviews, but also synthesizes them to quantify the overall effect size (Borenstein, Hedges, Higgins, & Rothstein, 2011; Lipsey & Wilson, 2001). Significance tests are used to determine this overall effect size. To acquire a more precise estimate of the true effect, this overall effect size can be corrected for artifacts resulting, for example, from the sample size in the primary studies (Lipsey & Wilson, 2001; Schmidt & Hunter, 2014). Moreover, in a meta-analysis, it is possible to conduct moderator or sensitivity analyses which might explain the heterogeneous findings and help develop theories about the processes behind the effects (Borenstein et al., 2011; Jak & Cheung, 2018). Whereas single studies

strongly depend on the composition and size of their sample as well as on their method, meta-analyses are able to make statements about the differences between the methods and about bigger and more heterogeneous samples which might be more representative of the population. At the same time, of course, the quality of meta-analytic results depends on the quality of the underlying primary studies and their comparability (Lipsey & Wilson, 2001). In single studies, treatments, measures, and concepts may vary. Meta-analyses are able to summarize findings on similar but not identical subjects and to identify moderating effects based on their differences.

1.2.2 How to conduct a meta-analysis

There is a lot of literature helping researchers on how to conduct successful meta-analyses (e.g., Borenstein et al., 2011; Card, 2012; Kisely et al., 2015; Lipsey & Wilson, 2001; Moher et al., 2009, 2015). At least two studies are needed to conduct a meta-analysis (Valentine, Pigott, & Rothstein, 2010). The starting point of a meta-analysis is a research question. This research question must be defined as concretely as possible (see PICOS, Moher et al., 2009, 2015). Depending on the research question, the researchers define the eligible inclusion and exclusion criteria for a study. In the next step, sources are identified for the literature search. These sources are mostly databases in the field of the research question (e.g., MEDLINE for medical studies or PsychINFO for psychological studies; Google Scholar can be used for every field). In addition to databases, researchers should also consider review articles as well as references to relevant articles, relevant journals and conferences, or directly contact authors who work on the subject. The whole search process should be documented so that it can be repeated at any time (see PRISMA statement, Moher et al., 2009, 2015). Researchers should provide a flow chart for their subsequent publication (see Moher et al., 2009, 2015), but also document the research process in more detail for themselves, including information on the source and the search terms.

When the literature search is finished, the coding process starts. The variables for the coding process should be selected depending on the research question. The Cochrane Collaboration provides a checklist of items to consider in data collection (Higgins & Green, 2011). These variables can be adjusted during the coding process, depending on the information provided in the primary studies. Additionally, it is recommended to code the quality of the primary study (e.g., Moher et al., 2015). There are several tools that have been developed for quality assessment (e.g., Armijo-Olivo et al., 2012; Higgins et al., 2013; Higgins & Green, 2011). At least two independent coders should conduct the coding process. The intercoder reliability should be estimated and reported in the subsequent publication (see Gamer, Lemon, Fellows, & Singh, 2012; Hayes & Krippendorff, 2007). When all studies have been coded, the statistical analysis is performed. To this end, there are different programs available (e.g., *Comprehensive Meta-Analysis*, Borenstein, Hedges, Higgins, & Rothstein, 2005; *Review Manager*, Cochrane Collaboration, 2014b; several R packages such as *metaphor*, Viechtbauer, 2010; or *meta*, Schwarzer, 2007).

Several steps should be undertaken when conducting a meta-analysis. For the mean effect size, researchers should decide which model applies best to the data: a fixed effects model or a random effects model (see Hedges & Vevea, 1998). When the effect sizes are combined from different studies, it is necessary to account for sampling error in the primary studies (fixed effects model), but also for a possible error caused by missing primary studies or effect sizes (Borenstein, Hedges, & Rothstein, 2007). The fixed effects model anticipates a rather homogeneous sample of studies with one true effect. The random effects model anticipates that each effect size differs somewhat from the true effect size, so the variance comes from sampling error and from random effects (Lipsey & Wilson, 2001). The combined effect under the random effects model is the mean of the population of all effect sizes, rather than one true effect size (Borenstein, et al., 2007). Therefore, the random effects model

accounts for greater variance and suits more heterogeneous study samples. Alongside the estimation of an overall effect size, analyses of publication bias (e.g., Eggers regression coefficient) as well as analyses on the heterogeneity of the primary studies are required. Additionally, moderator analyses or even meta-analytic structural equation models (MASEM; Cheung, 2015; Cheung & Hong, 2017) can be conducted. Again, there is a lot of literature that supports researchers in conducting these analyses (Borenstein et al., 2011; Cochrane Collaboration, 2014a; Schwarzer, Carpenter, & Rücker, 2015). Meta-analyses cannot derive causal relations from correlational data. They can only be conducted on samples of existing literature, which might make complex models hard to test (e.g., when not all primary studies report all relevant variables). Nevertheless, meta-analyses give a good and quantified overview of the existing research status and point to open questions and the next steps in a certain research area.

1.3 Meta-analyses and media research

With every new media, fears and uncertainties arise. Public discussions are often dominated by evidence from individual cases, because it is hard to communicate complex research findings comprehensibly. The following subchapters present three types of new media that have attracted public attention and been discussed controversially. What fears and stereotypes are present in the general discussion? How does science help answer the questions on possible media threats? And, if conducted, have meta-analyses helped to provide a clearer understanding or are there questions that remain unanswered?

1.3.1 Does internet usage make people stupid?

1.3.1.1 The expected threat

The *Google effect* describes the process of losing the ability to memorize information because Google is used as a personal memory bank (Latham, 2011). It is a common assumption that not only Google, but also general internet use is making people stupid (Carr,

2008; Roberts, 2015c), which is widely discussed for example in social media (Epipheo, 2013 with more than 2 million views and nearly 2,000 comments). On the one hand, and according to these statements, there is the Google effect, meaning that people do not have to learn things anymore, if they have permanently access to Google. Every time they need information, they can ask Google. Therefore, the existence of Google makes us less knowledgeable or educated. On the other hand, the constant distraction of the multiple media offerings on mobile phones might distract people's attention, hindering learning. Multitasking with electronic media may even reduce the intelligent quotient (Loder, 2014 with 65,112 views). The fear of this negative impact of internet use is especially relevant for children and adolescents who have not completed a proper education (Chamorro-Premuzic, 2013). However, there are opposing views on whether the internet makes children "stupid" (Mlot, 2013) or even smarter (Agrawal, 2017). A lot of researchers have investigated the relationships and the impact of internet use on intelligence and academic achievement of the younger generation.

1.3.1.2 *Empirical findings*

In line with the fears of parents and teachers, some empirical findings support a negative relationship between internet use and academic achievement (Ravizza, Hambrick, & Fenn, 2014), but the general research body is more heterogeneous with mixed findings (Bulman & Fairlie, 2016). Additionally, there are moderating variables such as gender and usage patterns (Senthil, 2018). Better grades have been reported in women who show a high level of information seeking and chatting on the internet. Lower grades have been reported in both genders who conduct a high level of online gaming activities (Chen & Tzeng, 2010). Socio-economic status has been shown to indirectly negative affect academic achievement, because lower income families focus more intensively on entertainment (Camerini, Schulz & Jeannet, 2018). It also influences performance outcome. While the grade point average was found to relate negatively to internet addiction, higher scores in English as foreign language

came with higher internet usage (Iyitoğlu & Çeliköz, 2017). In addition, the effect direction depended on the age of the user and the socio-economic status of the child's family (Wainer et al., 2008; Wainer, Vieira, & Melguizo, 2015). For younger children from low-income families, a negative relationship was found between internet use and grades, while for older children this relationship was positive. Considering the causal direction, a review by Anderson, Steen, and Stavropoulos (2017) reported bi-directional relationships between academic disposition and (problematic) internet use, based on five longitudinal studies. Another review concluded that, although cognitive changes happen, they seem to be favorable, especially for younger people who have grown up with this technology (Mills, 2016). Furthermore, Mills (2016) described that, in addition to acquiring a certain competence with technologies, an easier connection to peers might play a central role to success in everyday life. Especially for connecting with peers, the internet can be helpful. Social networking sites support the development of a social capital, which is associated with higher academic achievement (Ellison, Steinfeld, & Lampe, 2007, 2011; Stefanone, Kwon, & Lackaff, 2012). This theoretical consideration is contrary to the fears of many parents and teachers (e.g., Griffiths, 2018; Johnston, 2014).

1.3.1.3 *The research gap*

The first meta-analysis conducted in this dissertation project was inspired by these different explanations as well as by the heterogeneous study base. Meta-analytic evidence on internet use and academic achievement is rare and internet use is a wide construct which includes different types of usage. As there is no definitive conclusion on the internet's impact on academic achievement, meta-analytic summaries could help to synthesize the empirical study base.

There are many different ways of using the internet. As mentioned earlier, general internet use includes many different activities (e.g., SNS, online gaming, online pornography)

which are too heterogeneous to set out in a meta-analysis (Lipsey & Wilson, 2001). A big part of everyday internet activities is the use of online social network sites (SNS; Pew Research Center, 2018). It is reasonable that the use of SNS is rather different to the use of other internet offerings, such as online gaming or online pornography. Moreover, SNS use is very common especially in adolescents and young adults, who are in a phase in life where learning is central (Lenhart et al., 2015). Therefore, a meta-analysis of SNS use – as one of the most prevalent areas of internet use – and academic achievement was conducted.

When adolescents and young adults use SNS often, it is possible they spend time at SNS at the expense of other activities, such as studying (i.e., displacement hypothesis, Nie, 2001; Tokunaga, 2016). Moreover, the use of mobile devices has increased SNS use, resulting in at least 24 % of American adolescents being *constantly online* (Lenhart et al., 2015). This could mean that students are also constantly distracted from school classes. A multitasking use of SNS has been found to be negatively associated with academic achievement (Junco & Cotton, 2012). Therefore, the fears of parents and teachers seem to be reasonable. But there are also opportunities linked to SNS use. The purpose of SNSs is to connect with others and to facilitate communication. Students also use SNS to seek information and to discuss learning matter with their classmates (Lim & Richardson, 2016). SNS use helps individuals to develop a social capital, which can serve as a resource for academic achievement (Ellison et al., 2007, 2011; Liu et al., 2016).

Two reviews of general internet use were described earlier (Anderson et al., 2017; Mills, 2016). The next step is to also statistically synthesize the empirical evidence on internet use and academic achievement. To account for the different internet use types, the first meta-analytic summary presented in this dissertation investigated the association between one of the most common types of every day internet use (i.e. SNS use) and academic achievement.

1.3.2 Video games –Pure evil?

1.3.2.1 The expected threat

Another highly discussed topic is video or online games. Video gaming is a very popular leisure activity (60% of American adults play video games daily, Entertainment Software Association, 2018). However, negative attitudes toward video games are widely spread and discussed by the general public (e.g., Hymas, 2018; Williams, 2018), and especially violent video games are held responsible for aggressive and violent behavior in children, adolescents, and young adults (Bereta, 2014; Trump, 2018; Wolf, 2018). Video game playing is also assumed to influence a gamer's body composition. Video gaming has been held responsible for making people fat and lazy (e.g., Gaudiosi, 2011). Moreover, video games are held responsible for the social isolation of young men (Smith, 2017). Cases where gamers have died in front of the screen from gaming addiction have been reported in online social networks and the public media (Hunt & Ng, 2015; Planet Dolan ENTERTAINMENT, 2015; Roberts, 2015b). Gaming addiction is highly discussed in public media reports (CBS NEWS, 2018; Sarkis, 2014) and emphasized with cases of suicide (Roberts, 2015a). Although research has also found positive consequences (e.g., Bavelier, 2012; Gibbs, 2016), the public debate generally has a rather negative view of video gaming. The question is: Are these views merely based on personal evidence and single cases? How substantial is the impact of video gaming on these assumed negative outcomes? The association with aggression and violent behavior has been highly researched in the last decades and is highly relevant because of its assumed impact on school shootings (e.g., Campbell, 2018; Thomson, 2018). The following chapter will therefore focus on the empirical findings regarding the link between video gaming and aggression.

1.3.2.2 *Empirical findings*

In empirical research, the association between (violent) video gaming and aggression and violent behavior has received a lot of attention (e.g., Desai, Krishnan-Sarin, Cavallo, & Potenza, 2010; Gentile et al., 2009; Grüsser, Thalemann, & Griffiths, 2007; Kühn et al., 2018; Lobel, Engels, Stone, Burk, & Granic, 2017). At the same time, studies with negative outcomes generally seem to gain more attention in public debates (Copenhaver, Mitrofan, & Ferguson, 2017). To obtain a comprehensive overview of the empirical evidence, one has to look directly at the primary studies. However, the studies within this substantial research body (about 235,000 hits in Google Scholar for “video games and violence”) do not paint a clear picture. Some report significant associations between video gaming and aggression or associated variables such as everyday sadism (e.g., Cho, Lee, Choi, Choi, & Kim, 2017; Gonzalez & Greitemeyer, 2018; Verheijen, Burk, Stoltz, van den Berg, Cillessen, 2018; Willoughby, Adachi, & Good, 2012) or even describe the spread of video game induced violence and aggressiveness as epidemic (Greitemeyer, 2018). Other studies have found no relationships (e.g., Ferguson et al., 2017; Ferguson, Garza, Jerabeck, Ramos, & Galindo, 2013; Pan, Gao, Shi, Liu, Li, 2018) or explain why the significant findings could be wrong (Markey & Ferguson, 2017). Moreover, most studies report rather small to negligible effect sizes (e.g. Cho et al., 2017; Ferguson, 2015). Other variables, such as experiences of violence at home, are stronger predictors of aggression and violence (DeCamp, 2015).

To synthesize this research base, several meta-analyses have been published. On the one hand, some meta-analytic evidence revealed small to moderate effects of violent video games on aggression variables (Anderson et al., 2010; Anderson et al., 2004; Anderson & Bushman, 2001; Ferguson, 2015). On the other hand, there was also meta-analytic evidence in the opposite direction (Ferguson, 2007; Ferguson & Kilburn, 2009; Furuya-Kanamori, & Doi, 2016). These contradictory findings could be explained by the different meta-analytic

principles that were used by the different authors. For example, there is a debate on whether partial effect sizes should be included in meta-analyses or not (Ferguson, 2015; Rothstein & Bushman, 2015).

Although there is no 100% consensus, the findings on a meta-analytic level provide a clearer picture of a small but significant positive relationship between video gaming and aggression (Boxer, Groves, & Docherty, 2015; Lishner, Groves, & Chrobak, 2015). In terms of causality, longitudinal studies have provided evidence that video games influence behavior and not the other way around (Coyne, Warburton, Essig, & Stockdale, 2018; Teng et al., 2019; Verheijen et al., 2018). This example shows the importance of meta-analytic summaries, but also the challenges. Although different findings had been presented by different authors, the whole body of meta-analyses provided a conclusion on this highly discussed topic, fostering a debate on the methodological development of meta-analyses.

1.3.2.3 *The research gap*

The association between video gaming and aggression has been highly discussed, in the general public as well as in science, and already meta-analytically investigated. As mentioned earlier, the second largest prejudice related to video gaming concerns the body composition of the gamer (Grohol, 2014). People playing video games are often assumed to spend a lot of their leisure time sitting in front of a screen, eating unhealthy food, and therefore

gaining weight (e.g., Borland, 2011; Idol, n.d.). Although the connection between screen media – especially television use – and overweight is well supported (e.g., Buchanan et al., 2016; Sigmund et al., 2015), studies on video gaming have been less conclusive (e.g., Martinovic et al., 2015; Scharrer & Zeller, 2014). Indeed, video gaming is characterized by some attributes that other screen media do not show. For example, video gaming requires



Figure 2. Stereotypical gamer in South Parks' episode „Make Love, Not Warcraft“, Season 10, Episode 8.

active decision making to produce a story. When playing a video game, one has to guide the avatar through the game, with oneself partially merging with the avatar. Feelings of flow, involvement, transportation, and identification can develop (Bachen, Hernández-Ramos, Raphael, & Waldron, 2016; Brookes, 2010; Jennett et al., 2008; Klimmt, Hefner, Vorderer, Roth, & Blake, 2010). In stressful gaming situations, greater involvement may lead to stronger physical reactions (e.g., blood pressure, heart rate, etc.) and stronger physical reactions lead to higher energy expenditure (Wareham, Henning, Prentice, & Day, 1997). Additionally, playing video games requires more attention and actions with both hands, which leaves less time for parallel snacking of unhealthy foods (Tomlin et al., 2014). These differences might explain why – in contrast to television and general screen media – empirical evidence on video gaming and overweight is more heterogeneous. Because the rise of overweight and obesity is a pressing topic, especially in Western countries (World Health Organization, 2018), and video gaming is held responsible for weight gain, a summary of the existing evidence on this association is required. There is no recent meta-analysis published on this topic, although the research base is as complex as research on the association between video gaming and aggression. Consequently, the second part of this dissertation will focus on video gaming and excessive body mass as a second possible threat of media use.

1.3.3 Are social media destroying a whole generation?

1.3.3.1 The expected threat

Humans are social beings, so, not surprisingly, social media are one of the biggest media innovations in the last decades. A big part of everyday communication is now mediated through social media, although some people are skeptical about the quality of communication with social media (e.g., Steinmetz, 2018; Ultius, 2016). Some people claim that when face-to-face contacts are missing, one might become lonely and socially isolated; this argument is often brought forward in public debates on social media influences (e.g., Ludden, 2018;

Molloy, 2017; Young, 2018). Overall, social media affect people's well-being because they are assumed to impair self-esteem, mental health, human connections, quality of sleep, memory capacity, and attention span (Barr, 2018). While self-esteem is expected to have decreased, narcissism is assumed to have risen since the advent of social media (Firestone, 2012; Twenge, 2013). Depression is often linked with social media (Riley, 2018) and, as mentioned earlier, some authors describe the phenomenon as *digital depression* (Diefenbach & Ullrich, 2016). The negative impacts of social media on working memory, attention span, and sleep is expected to be associated with lower academic achievement (e.g., Bloxham, 2010; Pigott, 2015). Again, the general public voices a lot of fears about possible negative consequences of social media use, and science has made contributions on these questions.

1.3.3.2 *Empirical findings*

In terms of empirical research, some studies have found associations between Facebook use and loneliness or decreased well-being (e.g., Kross et al., 2013; Lemieux, Lajoie, & Trainor, 2013). However, other studies have not found any relationships, or even contradicting relationships, depending on the motives behind SNS use (e.g., Brusilovskiy, Townley, Snethen, & Salzer, 2016; Burke, 2013; Teppers, Luyckx, Klimstra, & Goossens, 2014). Social media might also work as a bridge for shy people. For shy or rather quiet people, establishing contact with others might be easier through social media (Baker & Oswald, 2010; Bardi & Brady, 2010; Brody, 2018). They may feel less inhibited to contact others in order to subsequently initiate a face-to-face meeting (Pierce, 2009). Social media have been found to be helpful for developing social capital (Ellison et al., 2007; 2011; Liu, Ainsworth, & Baumeister, 2016). In total, there are no conclusive findings on the effects of social media on loneliness and social isolation.

Positive relationships have been reported between SNS use and narcissism (e.g., Alloway, Runac, Quereshi, & Kemp, 2014; Andreassen, Pallesen, Griffiths, 2017; Leung,

2013). Social media allow users to only show their best sides and, therefore, obtain positive feedback (i.e., “likes”). Also, social media provide a platform for establishing and maintaining contact with many people, including people the user does not know in real life (e.g., followers on Twitter or Instagram). However, some studies were not able to confirm the anticipated relationship (e.g., Trzesniewski & Donnellan, 2010). Social media do not only provide positive feedback. The claim that narcissists use social media more, or that social media makes people more narcissistic is questionable, as the effects of social media on self-esteem depend on the type of feedback a user receives (Valkenburg, Peter, & Schouten, 2006). So, again, there is still no clear picture on the relationship between social media use and narcissism.

Research findings on the relationships between social media and academic achievement are very heterogeneous. The effect sizes vary in valence from negative to non-existent to even positive effects (e.g., Hargittai & Hsieh, 2010; Junco, 2015; Leung, 2015). On the one hand, scholars assume that the negative relationships found are due to the short duration of the study (i.e., time displacement; Tokunaga, 2016), multitasking with social media (e.g., Junco & Cotton, 2012), or poorer sleep quality (Xanidis & Brignell, 2016). On the other hand, social media provide social capital (Ellison et al., 2007) and a resource for academic achievement (Yu, Tian, Vogle, & Kwok, 2010). Because these findings are so heterogeneous, a conclusive summary is needed.

To identify possible social media correlates and consequences, there is a big body of single studies. Each study adds a piece to the puzzle, and several meta-analytic summaries have tried to assemble the puzzle. Four meta-analyses focused on the relationship between social media use and well-being (Huang, 2017; Liu & Baumeister, 2016; Mingoia, Hutchinson, Wilson, & Gleaves, 2017; Song et al., 2014). Three meta-analyses investigated the relationship between social media and narcissism (Gnambs & Appel, 2018; Liu &

Baumeister, 2016; McCain & Campbell, 2018). The relationship between social media and academic achievement was also summarized in three meta-analyses (Huang, 2018; Liu, Kirschner, & Karpinski, 2017; Marker, Gnambs, & Appel, 2018).

1.3.3.3 *The research gap*

Taken together, these meta-analyses addressed more than one possible media threat and may help to answer general questions on the negative impact of social media. Manuscript #3 will therefore review the existing meta-analyses on the three questions concerning social media correlates. Although meta-analyses with the same research question could be expected to produce similar results, the example of video games and aggression showed that meta-analyses can come to different conclusions (see Chapter 1.4.2.2). Therefore, one question will be: Are the results of meta-analyses on the same topics in line with each other, or do they produce conflicting results?

Due to the wide body of research, the method of meta-analysis is one of the most promising methods for providing conclusive answers on social media use. However, it is likely that there are no simple answers. In that case, meta-analyses provide information about moderator variables and mediating processes. A second question will therefore be: How and under which circumstances are social media dangerous?

1.4 Aims and objectives

The previous examples showed how complex empirical research on possible media threats can be. Single studies can be subject to a variety of errors, such as sampling or measurement errors, and have low power due to small sample sizes (Schmidt & Hunter, 2014; Szucs & Ioannidis, 2017). For highly discussed topics, researchers have provided a considerable amount of empirical evidence, and every single study is a puzzle piece that adds up to create a bigger picture. To assemble this puzzle, even media specialists need a certain amount of time and effort. And sometimes it is hard to identify which parts of an answer are

still missing. The previous example related to video games and violence showed that meta-analytic summaries can help provide clarity on the empirical evidence related to the relationships between digital media use and different correlates.

Systematic reviews and meta-analytic summaries are the best method for putting all pieces together. First, they summarize nearly all existing evidence and give an overview which can be processed faster. Second, meta-analyses are able to identify an overall effect size which can be interpreted more easily. Third, through moderator analyses, meta-analyses shed light on where the different results came from in the first place and point toward the next steps.

Therefore, this dissertation has two aims which were investigated in three papers. The first aim was to conduct two meta-analyses on pressing questions related to media use: social media use and academic achievement (see Manuscript #1) and video gaming and body mass (see Manuscript #2). The second aim was to take a closer look at existing meta-analytic evidence on social media threats (see Manuscript #3). Additionally, in the Discussion section, the effectiveness of the meta-analytical method in addressing questions in the field of media psychology and its impact on public discussions will be evaluated.

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Active on Facebook and failing at school? Meta-analytic findings on the relationship between online social networking activities and academic achievement

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Abstract The popularity of social networking sites (SNSs) among adolescents and young adults has raised concerns that the intensity of using these platforms might be associated with lower academic achievement. The empirical findings on this issue, however, are anything but conclusive. Therefore, we present four random-effects meta-analyses including 59 independent samples (total $N = 29,337$) on the association between patterns of SNS use and grades. The meta-analyses identified small negative effects of $\hat{\rho} = -.07$, 95% CI [-.12, -.02] for general SNS use and $\hat{\rho} = -.10$, 95% CI [-.16, -.05] for SNS use related to multitasking. General SNS use was unrelated to the time spent studying for school ($\hat{\rho} = -.03$, 95% CI [-0.11, 0.06]) and no support for the time displacement hypothesis could be found in a meta-analytical mediation analysis. SNS use for academic purposes exhibited a small positive association, $\hat{\rho} = .08$, 95% CI [.02, .14]. Hypotheses with regard to cross-cultural differences were not supported.

Keywords social networking sites, Facebook, academic achievement, grades, meta-analysis, time displacement

In the last ten years, online social networking sites (SNSs) such as Facebook, Twitter, or Instagram have become immensely popular. Facebook alone has reached a record number of 1.65 billion active users worldwide and, according to the company, the average user spends around 50 minutes per day on Facebook's platforms (Stewart, 2016). To no surprise, the correlates and consequences of SNS activities

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are among today's most debated questions among social scientists, journalists, and the general public alike. One of the key issues in the educational realm is the relationship between a student's use of SNSs and his or her achievement at school. Are heavy users of SNSs underperformers? So far, theoretic accounts as well as prior empirical studies on SNS activities and school achievement are not conclusive. Some have identified negative relationships between SNS use and grades (e.g., Karpinski, Kirschner, Ozer, Mellott, & Ochwo, 2013; Sendurur, Sendurur, & Yilmaz, 2015), whereas others found positive relationships (e.g., Asante, & Martey, 2015; Leung, 2015) or no relationships at all (e.g., Brubaker, 2014; Huang, 2014). The current work provides the first systematic summary of respective empirical research findings. We present three meta-analyses on the relationship between different types of SNS use and academic achievement. Our first meta-analysis is focuses on general SNS use, the second meta-analysis focuses on multitasking with SNS, and the third meta-analysis summarizes findings on SNS use for academic purposes. A fourth meta-analysis and a meta-analytical mediation analysis address the time spent studying and its relationship to SNS use. Moreover, we investigate the moderating role of the developmental status of the country in which the study was conducted.

SNS Activities and Students' Academic Achievement

Much of the initial research on the impact of the Internet more generally, and SNSs more specifically, emphasized the challenges and problems associated with these activities (cf. Bargh & McKenna, 2004; Chou, Condron, & Belland, 2005). Time displacement and multitasking are two main theoretical approaches that suggest a negative association between SNS activities and success at school.

From a time displacement perspective (Nie, 2001; Putnam, 2000; cf. Tokunaga, 2016) the time spent with SNSs is unavailable for supposedly more desirable behavior (such as learning or physical activities) that would have otherwise occurred. Based on this line of thinking, the time invested in using Facebook or Instagram must be traded off against time spent on other activities. SNS activities therefore impair academic achievement by reducing the time spent for knowledge acquisition such as the time for preparation for school and homework (e.g., Kirschner & Karpinski, 2010). From this perspective, SNS activities are conceptually similar to other pastime activities such as watching TV or playing sports. Findings on the relationship between intensive use of SNSs (e.g., time spent, frequency of logins) and the time spent for studying have been ambiguous, however. Whereas some scholars found a negative association (e.g., Brubaker, 2014), others' findings were mixed (e.g., Karpinski, 2013; Ozer, 2015). Thus, despite the intuitive appeal of the time displacement hypothesis to many (e.g., Salmon, 2014) related evidence is contested.

A second perspective suggesting a negative link between SNS use and school success is theory and research on multitasking, that is, the use of SNSs while other activities take place. Of particular relevance to school success are SNS activities that occur during knowledge acquisition such as instruction at school, homework, or studying. From this perspective, the emphasis is less on social media replacing the time spent for preparation and study (time displacement), rather, concurrent SNS activities are assumed to decrease the effectiveness of studying. SNSs distract by providing the affordance to check messages or news, and to communicate, which reduces the situational working memory capacity that can be used for the primary task at hand (van der Schuur, Baumgartner, Sumter, & Valkenburg, 2015; Wood et al., 2012).

In addition, scholars have argued that SNS behaviors likely reduce the quality and quantity of sleep (cf. Chassiakos, Radesky, Christakis, Moreno, & Cross, 2016). Cross-sectional data of young adults revealed an association between the duration and frequency of SNS use and sleep disturbance (Levenson, Shensa, Sidani, Colditz, & Primack, 2016). Participants in the highest quartile of daily SNS activities (vs. participants in the lowest quartile) were about twice as likely to self-report sleep disturbances. Sleep, in turn, is a well-established predictor of scholastic achievement (e.g., Dewald, Meijer, Oort, Kerkhof, & Bögels, 2010). SNS activities were related to increases in stress (Fox & Moreland, 2015), which would negatively affect sleep (e.g., Pillai, Roth, Mullins, & Drake, 2014), and stress is likely a direct predictor of impairments on demanding cognitive activities at home or at school (e.g., Kirschbaum, Wolf, May, & Wippich, 1996).

Fewer theoretical and empirical works emphasized the potentially positive association between SNSs activities and academic achievement. SNSs have been linked to social capital (e.g., Ellison, Steinfeld, & Lampe, 2007; Resnik, 2001), that is, a network of relationships between people that is used as a support for the achievement of individual or collective goals (Coleman, 1988). Higher social capital is associated with greater academic achievement (Eckles & Stradley, 2012). Engaging in SNSs can be a means to create a network that provides information and support and thus leads to positive academic outcomes (Johnson, 1981; Yu et al., 2010).

Therefore, depending on the theoretical perspective taken, the association between academic achievement and SNS activities could be negative or positive. These contradicting theoretical accounts are also reflected in the available research findings on the academic consequences of SNS use. Empirical research provided evidence for negative (e.g., Karpinski et al., 2013) as well as positive (e.g., Leung, 2015) and no associations (e.g., Pasek, More, & Hargittai, 2009).

The Current Meta-Analyses

Given the conflicting findings on the academic outcomes associated with intensive SNS use, the aim of the current work was to provide a meta-analytic overview of studies reporting on the associations between SNSs activities and indicators of school achievement such as the grade point average (GPA). In this regard, we pursued three objectives: First, we aimed at identifying the overall effect size to determine whether SNS use, on average, has the hypothesized negative relationship with academic outcomes (e.g., Karpinski et al., 2013) or rather a positive relationship as claimed by others (e.g., Leung, 2015).

Second, we examined two moderating influences – the type of SNS activity as well as cross-cultural differences – that might account for the divergent research findings in the published literature. We distinguished *a priori* between three patterns of SNSs use, a) general SNS use (such as time spent per day; frequency of posting with unspecified content), b) SNS use related to multitasking (e.g., using SNSs while studying), and c) SNS use in support of knowledge acquisition (e.g., using SNSs to communicate about school-related topics). Whereas the latter was assumed to have positive association with grades, we expected negative associations for the other SNSs activities. Therefore, we conducted three independent meta-analyses, one for each pattern of SNSs use, to identify their unique associations with school achievement as indicated by GPA or grades.

We also took a closer look at the regional origin of the sample. We assumed that for individuals in regions with lower socioeconomic development (as indicated by the Human Development Index [HDI]),

general SNS use intensity could reflect access to educational resources, whereas intensity of SNS use is less likely an indicator of access to educational resources in highly developed countries (Sobaih, Moustafa, Ghandforoush, & Khan, 2016). Thus, the relationship between general SNS use and academic achievement should be more positive in less developed countries than in highly developed countries.

We further conducted several sensitivity analyses. In addition to publication year and the sample's age, we analyzed the potential influence of the measure of academic achievement (self-reported vs. documented grades). Although self-reported grades were found to be highly correlated with actual grades in prior research (Kuncel, Credé, & Thomas, 2005; Shaw & Mattern, 2009), they tend to be less reliable indicators for students with low ability than for high performing students. We therefore saw a need for a closer investigation of this variable and investigated whether the academic grade measure could influence the relationship between SNS use and academic achievement. Moreover, we performed tests for publication bias to examine the robustness of our findings.

Third, we investigated the time displacement hypothesis in greater detail (Nie, 2001; Putnam, 2000) and examined whether SNS use replaced time for learning activities and school preparation (study time). To this end, a meta-analytic structural equation model (Cheung, 2015) tested the implied mediation effect of study time on the SNSs-GPA link. Overall, the current work addresses an important research lacuna and provides the first systematic quantitative synthesis of the empirical findings on the academic associations of intensive SNSs use.

Method

Meta-Analytic Database

Search process. Relevant studies were identified from searching the PsychINFO and ERIC databases combining the search terms "Facebook", "social network sites", "Twitter", "Instagram", "Myspace", "Weibo", "Renren", "StudiVZ", or "Google+" and "school achievement", "academic achievement", "success", "performance", "GPA", or "grades". Additional studies were retrieved from a similar search in Google Scholar. We also checked the references of all relevant articles and asked for additional studies or datasets via e-mailing lists and forums of different organizations in the fields of psychology and education (see Figure 1 for a flowchart of our search process). This resulted in 765 potentially relevant studies.

Inclusion criteria. Studies included in the meta-analytic database had to meet the following criteria: (a) The study contained a measure of SNS behavior (e.g., a measure of frequency, intensity, or specific activities), (b) the study included a measure of achievement at school in the form of GPA or grades, and (c) the sample size and a measure of association (i.e., a correlation or regression coefficient) between SNS use and academic achievement were reported. Studies that included only Internet-related activities but not necessarily SNS-related activities (e.g., general Internet use, instant messaging, online gaming) were excluded as were measures that did not address SNS use but rather the motivation to use SNSs or attitudes towards SNSs. Comparisons between SNS users and non-users (e.g., being a member in one or more SNSs) were also not considered. Moreover, studies with measures on cognitive performance (e.g., intelligence test scores) rather than school grades were not included in the analyses

because grades and cognitive abilities are only moderately correlated and represent unique constructs (Poropat, 2009; Richardson, Abraham, & Bond, 2012).

For potentially eligible studies that did not report relevant information or that reported conflicting information, we contacted the respective authors and included the study whenever the missing information could be obtained. After applying these criteria, we identified 50 publications reporting on 59 independent samples. Of these publications, 46 were included in the meta-analysis on general SNS use (55 samples), eight publications were included in the meta-analysis on multitasking SNS use (15 samples), and nine publications (ten samples) were included in the meta-analysis on using SNS use for academic purposes. Table 1 provides an overview of all independent samples included in our analysis. In the included studies students typically answered questions about their use of SNSs with the help of paper-and-pencil questionnaires or through online surveys. In around two thirds of the studies the students further reported on their academic success, with the large majority of surveys asking for GPA. In one third of the studies grades were obtained from school records.

Coding process. In the first step, the authors developed a coding protocol that defined all relevant information to be extracted from each publication and gave guidelines concerning the range of potential values for each variable. Then, two coders were trained who independently extracted the relevant data (i.e., effect sizes, descriptive information, moderator variables) from each publication.

Effect sizes between students' SNS use and their grades were coded (correlation coefficients, if unavailable then standardized regression weights were used). The respective intercoder reliability for these effect sizes was Krippendorff's (1970) $\alpha = 1.00$ (based on a subset of 120 effect sizes). Moreover, effect sizes pertaining to the relationship between SNSs use and time spent on learning (study time) as well as between time spent on learning and academic performance were retrieved. The intercoder reliability for these effect sizes was again very good with Krippendorff's (1970) $\alpha = 1.00$.

We further coded the operationalization of the SNS activity and distinguished between a general use of SNS, a multitasking way of SNS use, and SNS use for academic purposes. Measures of general SNS use were defined as measures of SNS use with no specified connection to school or academia (e.g., time spent on SNS). Measures of multitasking SNS use were defined as measures that asked for SNS activities that occurred during times of instruction or preparation but were unrelated to the content of the instruction (e.g., checking news on SNSs at times of homework). Measures of SNS use for academic purposes were defined as measures of SNS activities meant to support knowledge acquisition (e.g., using a Facebook group to discuss learning matter). In addition, we extracted several variables for our moderator and sensitivity analyses. The economic and social developmental status of the country in which the study was conducted was coded with the help of the four categories of the Human Development Index (HDI, United Nations Development Program, 2014, see supplementary material). We further coded the publication status (published vs. unpublished studies) and type of academic achievement measure (self-reported vs. documented). Because 26 studies did not report the mean age of the respondents, we coded the sample background in two categories (adolescents vs. undergraduates). Finally, the recency of the findings (i.e., publication year) was coded and analyzed as a continuous variable.

Meta-Analytic Procedure

The meta-analyses were conducted following the guidelines of the PRISMA statement (Moher, Liberati, Tetzlaff, & Altman, 2009) as well as standard procedures and recommendations for the social and medical sciences (Lipsey & Wilson, 2001).

Effect Size. In each meta-analysis, the zero-order Pearson product moment correlation was the focal effect size. All correlations were coded in a way that positive correlations reflect a finding that students who use SNSs more intensively do better at school or college than students who use SNSs less. For studies that only reported standardized regression weights from multiple regression analyses (and zero-order associations could not be obtained by contacting the researchers) correlation coefficients were approximated using the formula in Peterson and Brown (2005). Although this approach is discussed controversially (see Rosenthal & DiMatteo, 2001; Ferguson, 2015; Rothstein & Bushman, 2015), excluding these effects would reduce the power of our analyses and, if reporting standards were systematically associated with the size of the effects, bias our meta-analytic results. Therefore, we included these effects sizes (see also, for example, Allen, Walter, & McDermott, 2017; Robles, Slatcher, Trombello, & McGinn, 2014; van Geel, Vedder, & Tanilon, 2014) and conducted sensitivity analyses to evaluate their impact on the pooled correlation. If a study reported multiple effect sizes for two or more eligible associations (e.g., scores for two general SNS use measures were each correlated with GPA) these effects were averaged to guarantee independence of effect sizes.

Univariate Meta-Analyses. The effect sizes were pooled using the random-effects approach proposed by Hedges and Vevea (1998). Following standard procedures, the correlations were converted into a standard normal metric using a Fisher's Z transformation and converted back for the presentation of the results. To account for sampling error, each effect size was weighted by the inverse of its variance. The homogeneity of the effects sizes was tested using the χ^2 -distributed Q-statistic (Cochran, 1954). Because this test frequently exhibits a rather poor power (e.g., Sánchez-Meca & Marín-Martínez, 1997), we more strongly relied on I^2 that indicates the percentage of the total variance in observed effects due to random variance (Higgins, Thompson, Deeks, & Altman, 2003). Prevalent rules of thumb suggest that I^2 of .25, .50, and .75 indicate low, medium, and high heterogeneity, respectively. Categorical moderators were evaluated with subgroup analyses, whereas continuous moderators were examined using meta-regression analyses (Hedges & Pigott, 2004). The meta-analytic models were estimated with the software *Comprehensive Meta-Analysis, Version 2* (Borenstein, Hedges, Higgins, & Rothstein, 2005).

Meta-Analytic Structural Equation Analysis. The mediation effect implied by the time displacement hypothesis was examined by extending the univariate meta-analyses to a meta-analytic structural equation model (MASEM; Bergh et al., 2016; Cheung, 2015). To this end, three univariate meta-analyses (see above) were conducted that derived the pooled associations between general SNS use and GPA, general SNS use and study time, as well as study time and GPA. Subsequently, the correlation matrix formed by these pooled correlations was subjected to a conventional path analysis in *lavaan* version 0.5-23.1097 (Rosseel, 2012) using a maximum likelihood estimator. This analysis specified two regressions representing the hypothesized mediation effect: GPA was regressed on SNS use and study time, whereas study time was regressed on SNS use. This analysis used the smallest total sample size from the three meta-analyses for the calculation of the parameters' standard errors (and consequently the significance tests).

Publication Bias. A potential publication bias was examined in three ways: First, we compared effects from published studies (e.g., in journal articles or books) to effects from unpublished studies (e.g., in theses or conference proceedings) to examine whether systematically different effects were reported. Second, a regression test (Egger, Smith, Schneider, & Minder, 1997) was used to test for funnel plot asymmetry, an indicator of small study effects. Third, we estimated the number of studies with null-effects that needed to be included in the meta-analysis for the pooled effect to become non-significant (Rosenthal, 1979).

Results

General SNS Use and Academic Achievement

Pooled effect. The average effect of the relationship between general SNS use and academic achievement over $k = 55$ independent samples was $\hat{\rho} = -.07$, 95% CI [-0.12, -0.02] (Table 2). Thus, more intensive general SNS use was associated with significantly lower academic achievement. However, there was substantial heterogeneity between the effect sizes, $I^2 = 93.30$, $Q(54) = 805.95$, $p < .001$. About 93% of the observed variance in the effect sizes was due to differences between samples rather than sampling error. We assumed that the developmental status of the country in which the study was conducted would predict the association between general SNS use and achievement. Among the studies included in our analysis 36 out of 55 were conducted in very highly developed countries (e.g., USA, Australia). Ten samples originated from highly developed countries (e.g., China, Thailand) and nine from medium or low developed countries (e.g., South Africa, Ethiopia). In contrast to our predictions, the developmental status did not influence our findings, $Q(2) = 0.64$, $p = .73$ (see Table 3).

Analyses of sampling bias. A common problem for meta-analyses is the fact that studies with small sample sizes, non-significant effects, or even contradictory effect directions are often not published and hard to find. This could lead to an overestimation of the meta-analytic effect size. To identify such *small studies effects* we first plotted the effect sizes against the standard error of the studies. A visual inspection of the funnel plot did not suggest a small study effect (see supplementary material for the funnel plots). Moreover, the regression test was not significant, $B = -0.73$, $SE = 1.27$, 95% CI [-3.28; 1.81], $p = .57$, further corroborating the finding of no substantial publication bias. A fail-safe N analysis (Rosenthal, 1979) indicated that 1,124 unpublished studies with a null effect would be needed to reduce the p -value to non-significance. More than one third of our studies were unpublished, so we compared published with non-published effects. This analysis yielded a non-significant difference, $Q(1) = 1.64$, $p = .20$, showing that the effect sizes did not systematically depend on the publication status. In sum, we found no indication of substantial publication bias.

Sensitivity analyses. We conducted several additional analyses to examine the robustness of our findings (see Table 3). The sensitivity analyses included the type of academic achievement measure (self-reported vs. documented), type of effect size reported (correlational data vs. regression weights), the sample background (adolescents vs. undergraduates), and the year of publication. We found a significant difference between studies that were based on self-reported achievement measures ($k = 41$) as compared to studies that were based on documented grades ($k = 14$), $Q(1) = 7.27$, $p < .01$. The former had a significantly negative relationship with general SNS use on average, $\hat{\rho} = -.09$, 95% CI [-0.15, -0.03], $p <$

.01, whereas studies that were based on documented achievement showed a non-significant effect, $\hat{\rho} = .01$, 95% CI [-0.02, 0.04], $p = .60$. Moreover, studies that were based on zero-order correlations ($k = 41$) differed from studies that reported regression analyses and thereby controlled for other variables ($k = 14$), $Q(1) = 7.27$, $p < .01$. Studies that reported zero-order correlations yielded a significantly negative relationship between academic achievement and general SNS use, $\hat{\rho} = -.11$, 95% CI [-0.17, -0.05], $p < .01$, whereas studies that reported regression weights yielded no significant relationship, $\hat{\rho} = .03$, 95% CI [-0.05, 0.11], $p = .45$. Sample age (adolescents vs. undergraduates) did not affect the average association between academic achievement and general SNS use. Likewise, the publication year had no effect on the results, $B = -.003$, $SE = .003$, 95% CI [-0.010, 0.003], $p = .32$.

Multitasking SNS Use and Academic Achievement

Pooled effect. The average effect for the relationship between multitasking SNS use and academic achievement in $k = 15$ samples was $\hat{\rho} = -.10$, 95% CI [-0.16, -0.05] (Table 2). This indicates a small but significant negative association, suggesting that more SNS use in the form of multitasking goes along with lower school achievement. The homogeneity analysis yielded a significant effect, $Q(14) = 83.40$, $p < .001$, showing heterogeneous effect sizes. Quantifying this heterogeneity with $I^2 = 83.21$ indicated that 83% of the variance in the effect sizes was due to differences between samples rather than sampling error. However, the developmental status of the study countries showed little variation. The majority of studies were conducted in countries with very high development ($k = 14$), one study was conducted in a country with high development. As a consequence, no significant moderating effects of the countries' developmental status could be identified (see Table 4).

Analyses of sampling bias. To identify a potential small studies effect we again plotted the effect sizes against the standard error. The funnel plot showed that most of the studies with large sample sizes and were located around the mean effect, and the funnel plot did not suggest a small studies effect regarding multitasking SNS use and academic achievement. Egger's regression test amounted to $B = -1.31$, $SE = 1.68$, 95% CI [-4.95, 2.33], $p = .45$, supporting the assumption of no publication bias. A fail-safe N analysis indicated that 236 studies with a null effect would be needed to reduce the p -value of the average effect size to be non-significant. The effect size did not systematically depend on the publication status, $Q(1) = 0.01$, $p = .94$. Published studies ($k = 10$) yielded similar results as unpublished work ($k = 5$). No indication of substantial publication bias was found.

Sensitivity analyses. As in the previous meta-analysis, we examined the type of achievement measure (self-reported vs. documented), reported effect size (correlational data vs. regression weights), sample background (adolescents vs. undergraduates/adults), as potential moderators explaining the heterogeneity between samples. None of these factors significantly affected our results (see Table 4). We conducted a meta-regression to analyze publication year as a potential continuous factor, and found a significant trend over time, $B = -.021$, $SE = .008$, 95% CI [-.036, -.006], $p = .006$. The association between SNS multitasking and academic achievement was more negative in the more recent studies. This finding is based on 15 independent samples from work published between 2009 and 2015, thus, the rather small database precludes too bold conclusions. That said, this trend could reflect a rise in students' multitasking and the related association with student grades during a time in which smartphones have become ubiquitous for students, and SNSs can be accessed more easily at times and in places of preparation and instruction.

SNS Use for Academic Purposes and Academic Achievement

Pooled effect. The average relationship between SNS use for academic purposes and academic achievement over $k = 10$ independent samples was $\hat{\rho} = .08$, 95% CI [0.02, 0.14] (Table 2). Thus, the results showed a significant effect in the positive direction, indicating that academic achievement is positively related to intensive SNS use, as long as SNSs are used for academic purposes. A test of homogeneity showed a significant result of $Q(9) = 19.37$, $p = .02$, that indicates a variation of the effect sizes between samples, $I^2 = 53.53$. Therefore, we also conducted a moderator analysis for the developmental status of the country the study was conducted. Only very highly developed countries ($k = 7$) and highly developed countries ($k = 3$) were present, yielding no significant difference, $Q(1) = 0.021$, $p = .89$ (see Table 5).

Analyses of sampling bias. To identify a small sample effect we plotted the effect sizes against their standard errors. The funnel plot showed no systematic asymmetry. Egger's regression test was $B = 2.17$, $SE = 1.45$, 95% CI [-1.18; 5.52], $p = .173$, which also supported the assumption of non-existing publication bias. A fail-safe N analysis indicated that 24 studies with null effects would be needed to reduce the p -value of the average effect size to be non-significant. The publication status did not significantly influence the results, $Q(1) = 0.69$, $p = .41$. Published studies ($k = 5$) yielded similar results as unpublished work ($k = 5$). In sum, none of our indicators showed a noteworthy sign of publication bias.

Sensitivity analyses. Sensitivity analyses for the type of academic achievement measure (self-reported vs. documented), and type of effect size reported (correlational data vs. regression weights) identified no significant differences between these contextual conditions (Table 5). The age group showed little variance with all but one sample consisting of undergraduates. Year of publication had no influence on the results, $B = -.008$, $SE = .013$, 95% CI [-.033, .017], $p = .52$.

Examining the Time Displacement Hypothesis.

Pooled effects. The time spent on learning and school preparation was expected to mediate the effect of general SNSs use on academic performance. Therefore, three univariate meta-analyses were conducted that quantified the associations between SNSs use, GPA, and study time. The pooled effect for the relationship between general SNS use and academic achievement was previously estimated as $\hat{\rho} = -.07$ (see above). Moreover, the average relationship between study time and academic achievement over $k = 14$ independent samples was estimated as $\hat{\rho} = .15$, 95% CI [0.06, 0.25] (Table 2). Thus, study times were significantly associated with academic achievement. In contrast, general SNSs use did not exhibit respective associations with study times. The average relationship between general SNS use and study time over $k = 10$ independent samples was $\hat{\rho} = -.03$, 95% CI [-0.11, 0.06] (Table 2).

Meta-Analytic Structural Equation Model. Based on the pooled correlations reported in the previous section, we estimated the mediation model presented in Figure 2. In line with the univariate meta-analyses, SNSs use ($\beta = -.07$, $SE = .01$, $p < .001$) and study time ($\beta = .15$, $SE = .01$, $p < .001$) had significant main effects on GPA. However, there was no indirect effect of SNSs use on GPA via study time ($B = -.00$, $SE = .00$, $p = .17$). These results offer no support for the time displacement hypothesis.

Discussion

Social Networking Sites (SNSs) have become a mainstay in the lives of many adolescents and adults worldwide. With the growing popularity of SNSs, teachers, parents, and popular media have expressed worries regarding the academic consequences of students being active on Facebook, Instagram, and other SNSs, and SNSs have been blamed for students' bad grades (Bloxham, 2010; Trapp, 2016). Theoretical perspectives have highlighted the risks as well as the opportunities of SNSs in the academic realm. Empirical studies that connected measures of SNS use on the one hand and achievement-related variables on the other yielded conflicting evidence (e.g., Junco, 2012a; Khan et al., 2014; Kirschner & Karpinski, 2010; Hargittai & Hsieh, 2010). Against this background, the aim of the current work was to provide a quantitative, meta-analytic summary of the empirical findings on the relationship between the intensity of SNS activities and school achievement. We distinguished a priori between three aspects of SNS use, general SNS use (such as time spent per day; frequency of posting with unspecified content), SNS use related to multitasking (e.g., using SNSs while studying), and SNS use connected to preparation and learning for school (e.g., using SNSs to communicate about school-related topics). Based on these three groups of activities, three separate meta-analyses were conducted. A fourth meta-analysis and a subsequent mediation analysis examined the influence of SNS use on the time spent on studying, a supposed mediator to explain a negative link between SNS use and achievement (time displacement hypothesis).

As expected, we identified a positive relationship between school-related SNS use and academic achievement. The more active students are in school-related SNS activities the better are their grades. However, albeit significant, the respective correlation was rather small ($\hat{\rho} = .08$), following Cohen's (1992) often-cited framework for interpreting effect sizes. Similar, in Hattie's (2011; 2015) highly cited summary of meta-analyses on influences related to student achievement, effects up to $r = .10$ were well-below the average effect ($r = .20$) and were considered negligible, not worth wasting educators' time. Our meta-analytic assessment of the association between school grades and multitasking SNS activities showed an association of similar size, however, in the negative direction ($\hat{\rho} = -.10$). In line with prior theory (e.g., van Schuur et al., 2015), using SNSs for non-academic purposes at times of preparation and learning was related to lower school grades. A similar relationship was found in our largest dataset that relied on measures of general SNS use, such as the time spent with SNSs per day or the frequency of log-ins. The average association between achievement and general SNS use amounted to $\hat{\rho} = -.07$ indicating that overall SNS use was significantly, but weakly, associated with lower academic achievement.

We further provided the first meta-analytical assessment of the time displacement hypothesis. We found no significant association between general SNS use and the time spent studying, and consequently time spent studying did not serve as a mediating variable of the association between general SNS use and achievement. Based on these results we conclude that the current empirical literature is in no support of the time displacement hypothesis.

In all three meta-analyses that related SNS activities to school grades, substantial heterogeneity between the effect sizes was observed that could not be accounted for by mere sampling error. Therefore, a further objective was to identify variables that might help explaining variations in the association between SNS use and academic achievement. Over and above our separate analyses of general,

multitasking, and academic use of SNSs, we investigated whether the cultural background of a sample moderated the effects. We assumed that the intensity of SNS activities would reflect the access to informational resources in samples outside the very highly developed Western countries. Thus, in less developed countries, more positive relationships between general SNS use and achievement should be observed. However, the countries' developmental status (as indicated by the HDI; United Nations Development Program, 2014) did not predict the association between SNS use and academic achievement. Although our study sample did include studies that were conducted in countries with low or medium developmental status (such as Nigeria, Ethiopia, Ghana, Jordan, or Malaysia) these were few and the majority of research was conducted in the US and other very highly developed countries (e.g., Sweden, New Zealand). This limitation has reduced the chance of identifying meaningful differences. Moreover, the null effect could have been due to a generally high socio-economic status of the students who participated in the primary studies, irrespective of a country's HDI. When only high socioeconomic status students were included in the study, high access to informational resources would be expected for all participants.

However, our sensitivity analyses yielded four remarkable results. First, studies that utilized a self-report measure as the indicator of school achievement showed a significantly negative relationship between general SNS use and achievement, whereas studies that utilized documented grades as the indicator of school achievement identified almost a null-effect. This finding is noteworthy, as prior research suggests that self-reported grades are highly correlated with real, documented grades (Kuncel, Credé, & Thomas, 2005; Shaw & Mattern, 2009). If, however, self-reported and documented grades diverge, students tend to underreport rather than overreport their grades. One possible reason for the difference between studies using self-reported versus documented grades could be a stronger social desirability bias in the former set of studies (see Cole & Gonyea, 2010). Individual differences in social desirability could potentially lead to higher self-reported grades (e.g., less underreporting) and lower self-reported SNS use, resulting in a spurious relationship between these variables. Thus, despite the small negative association observed in the overall sample it is conceivable that SNS activities actually do not have any relationship with academic outcomes at all.

We further examined effect size differences between studies that reported zero-order correlations and studies that reported beta coefficients, with the latter controlling for third variables as part of a multiple regression. The results highlighted that studies that reported zero-order correlations showed a significant average effect, whereas studies that reported the standardized beta-weights showed no average relationship. We transformed beta weights with the help of a formula by Peterson and Brown (2005), which is a common procedure in meta-analytic research. Whether or not betas should be included in a meta-analysis in the first place is a matter of ongoing debate, however, some argue for inclusion (e.g., Rosenthal & DiMatteo, 2001; Ferguson, 2015), others are more critical (e.g., Rothstein & Bushman, 2015). Third, our analysis of multitasking SNS use and achievement showed that the relationship was more negative in more recent studies. This finding, despite being based on a rather small number of studies, could reflect the rise of mobile Internet access and the proliferation of mobile SNS activities. As of fall 2016, 92% of Facebook's active monthly users access the platform at least sometimes with a mobile device and more than 50% of the active users access the platform with a mobile device exclusively (Facebook, 2016). Thus, SNS multitasking has become a possibility everywhere in students' homes, libraries, and schools. From this perspective, the average meta-analytical relationship between

multitasking SNS use and achievement presented here (i.e., work published from 2009 to 2015) could be slightly lower than the association expected for today's students who live in a smartphone-saturated environment.

Finally, the observed heterogeneity in effect sizes could be partially attributed to the age group the study was based on. Whereas studies with undergraduates showed a negative relationship between general SNS use and academic achievement ($\hat{\rho} = -.08$), there was no such association in studies with adolescents ($\hat{\rho} = .01$). Thus, negative associations observed for older participants are absent in the group of adolescents. So far, it is unclear whether these differences are due to age effects or rather systematic cohort differences. Much of the recent journalistic discourse in the field is focused on the cohort of post-millennials (*Generation Z*, e.g., Williams, 2015), and their supposedly unique psychological responses to new media technologies. Little scientific evidence is available to back these supposed cohort effects. Despite these intriguing moderating effects, it should be kept in mind that we had no *a priori* hypotheses guiding these analyses. Therefore, these exploratory analyses should be extended in future research that, for example, explicitly accounts for the potentially confounding influence of social desirability bias in SNS research or disentangles potential age effects from cohort differences.

Limitations and Directions for Future Research

Some limitations might compromise the generalization of our findings thereby pointing out the need for additional research. First, the cross-sectional design of the pooled primary studies prohibits causal interpretations of our results. Do SNSs activities result in poorer academic achievements or, rather, are academic underperformers more likely to engage in SNSs? Causal conclusions require longitudinal studies examining how the interplay between SNSs use and academic achievements evolves over time. However, the limited longitudinal evidence that is available so far (e.g., Leung, 2015) corroborated a positive effect of general SNSs use on changes in overall grades within one year. Moreover, all previous research was limited to the examination of linear associations between SNSs activities and academic achievement. However, it is conceivable that moderate degrees of SNSs use might be harmless and yield no detrimental effects, whereas an excessive time spent on Facebook or related platforms result in more negative consequences—for example, excessive SNSs use has been associated with addiction symptoms and clinical disorders (e.g., Kuss & Griffiths, 2011a; 2011b; see Gnambs & Appel, 2017a, for an analysis of linear and non-linear relationships between gaming and intelligence). Future studies are encouraged to identify particularly harmful patterns of SNS use by examining linear as well as non-linear relationships.

Second, our meta-analyses identified a substantial amount of unaccounted variance between samples that could not be explained by the examined moderators. This opens intriguing possibilities for the identification of additional moderating influences. For example, it is reasonable to assume that intensive SNSs use has particularly adverse effects if parents neglect to monitor their children's studying times, particularly during examination periods, and do not track their academic progress. Today, little is known as to how SNS-related parenting (and media-related parenting more generally) affects achievement-related student behaviors or school achievement (cf. Nathanson, 2013). Moreover, students' own ability to regulate behavior could explain differences between samples and individuals (cf. Hofmann, Reinecke, Meier, & Oliver, 2017). Experience sampling data suggests that giving in to media desires is a common expression of self-control failure in everyday life (Hofmann, Vohs, & Baumeister, 2012). Using

SNSs for procrastination could not only explain lower well-being (Meier, Reinecke, & Meltzer, 2016) but the efficacy of studying and preparation for school exams and resulting grades. On the level of sample background, variables other than the HDI (which did not moderate our findings) could play a role (cf. Gnams & Appel, 2017b). Theory-guided research on cultural differences could focus on Hofstede's cultural dimensions or Schwartz's value system (e.g., Hofstede, Hofstede, & Minkov, 2010; Schwartz, 2006) to explain the varying role of SNSs regarding educational outcomes.

Third, due to lack of primary studies that related SNS use to sleep or to stress in combination with school achievement, promising mediating paths as well as important moderating variables remain untested. Rather than the time spent studying, sleep quality and quantity could be a crucial link between SNS activities on school achievement. As a consequence, SNSs activities that take place during the nighttime should be more negatively associated with school achievement than similar activities during the afternoon. More studies with a fine-grained assessment of social media activities are needed to test this prediction, preferably using ambulatory assessment or time diary methods. The smartphone itself provides means not only to track social media activities, but to record sleep patterns (see Min et al., 2014, and Patel, Kim, & Brooks, 2017, for methodological challenges).

Conclusion

The current paper presented four meta-analyses on the relationship between SNS use and academic achievement. Our work underscores the notion that SNS use is positively associated with academic achievement as long as SNS use is school-related. This is in contrast to fears of many parents and teachers that the influence of SNS is inevitable detrimental for academic achievement. SNS use unrelated to school, however, was associated with poorer academic achievement. However, all correlations identified in these meta-analyses were rather weak, only a small part of students' achievement at school and university co-varied with SNS use. A meta-analytic investigation of the time displacement hypothesis found no support for the assumption that the intensity of social media activities is associated with less time spent for studying. Despite the proliferation of SNSs in societies around the world, social networking activities appear to be only weakly related to academic achievement.

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Table 1.

Main Characteristics of the Primary Studies

No.	Study	Sample; Origin	<i>N</i>	SNS Variable(s)	Academic achievement variable(s)	Effect size
1.	Abdulahi, Samadi, & Gharleghi, 2014	Mostly adults; Malaysia	152	Time spent on Facebook	Self-reported grades	-.37 (G)
2.	Abu-Shanab, & Al-Tarawneh, 2015	Adolescents; Jordan	113	Time spent on Facebook	Documented GPA	-.06 (G)
3.	Adebisi et al., 2015	Undergraduates; Nigeria	239	Time spent on SNSs	Self-reported GPA	-.23 (G)
4.	Alexander, 2013	Adolescents; USA	72	Facebook Intensity Scale	Documented GPA	-.23 (G)
5.	Al-Menayes, 2015	Undergraduates; Kuwait	1,327	Time spent on SNS	Self-reported GPA	-.09 (G)
6.	Asante, & Martey, 2015	Undergraduates; Ghana	701	Multi-item general SNS use measure	Self-reported GPA	.42 (G)
7.	Brubaker, 2014	Undergraduates; USA	73	Time spent on Facebook; Facebook multitasking; Facebook to get help/help others with homework	Documented GPA	.03 (G) .02 (M) .06 (A)
8.	Cepe, 2014 Sample 1	Adolescents; New Zealand	106	Frequency of checking Facebook; time spent on Facebook	Self-reported grades	-.10 (G)
9.	Cepe, 2014 Sample 2	Undergraduates; New Zealand	211	Frequency of checking Facebook; time spent on Facebook	Self-reported grades	-.05 (G)
10.	Cohen, 2011	Undergraduates; USA	283	Frequency of checking Facebook	Self-reported GPA	-.14 (G)

11.	Golub, & Miloloža, 2010	Undergraduates; Croatia	277	Multi-item measure of Facebook use (several activities); Facebook multitasking with homework; Frequency of communication with professors/ on academic matters	Self-reported GPA	-.07 (G) -.06 (M) .08 (A)
12.	Gray et al., 2013	Undergraduates; USA	338	Multi-item measure of Facebook use (several activities); Facebook collaboration	Documented GPA	.05 (G) .13 (A)
13.	Hasnain, Nasreen, & Ijaz, 2015	Undergraduates; Pakistan	171	Multi-item measure of SNS use	Multi-item measure of academic performance (including self-reported GPA)	-.24 (G)
14.	Helton, 2011	Undergraduates; USA	199	Time spent on Facebook	Self-reported GPA	-.21 (G)
15.	Hirsh, 2012	Undergraduates; USA	44 ^b ; 116 ^c	Time spent on SNS; quantity of tweets	Self-reported expected final grade ^a	.06 (G)
16.	Huang, 2014	Adolescents; China	1,535	Multi-item measure of SNS use (time spent and number of friends)	Self-reported grades	.01 (G)
17.	Hyatt, 2011	Undergraduates; USA	613	Time spent on SNS	Self-reported GPA	-.11 (G)
18.	Iorliam & Ode, 2014	Undergraduates; Nigeria	1,560	Time spent on Facebook	Self-reported GPA	-.32 (G)
19.	Jacobsen & Forste, 2011	Undergraduates; USA	1,026	Time spent on Facebook	Self-reported GPA	-.07 (G)
20.	Jamil et al., 2013	Undergraduates; Pakistan	275	Facebook Intensity Scale	Self-reported GPA	-.09 (G)
21.	Junco, 2015 Sample 1	University Freshmen; USA	437	Time spent on Facebook; Frequency of several Facebook activities; Facebook multitasking	Documented GPA	.01 (G) -.13 (M)

22.	Junco, 2015 Sample 2	University Sophomores; USA	401	Time spent on Facebook; Frequency of several Facebook activities; Facebook multitasking	Documented GPA	.04 (G) -.13 (M)
23.	Junco, 2015 Sample 3	University Juniors; USA	345	Time spent on Facebook; Frequency of several Facebook activities; Facebook multitasking	Documented GPA	.02 (G) -.14 (M)
24.	Junco, 2015 Sample 4	University Seniors; USA	406	Time spent on Facebook; Frequency of several Facebook activities; Facebook multitasking	Documented GPA	.02 (G) -.01 (M)
25.	Junco, 2012a	Undergraduates; USA	1,771 to 1,776 ^d	Time spent on Facebook; Frequency of several Facebook activities	Documented GPA	.01 (G)
26.	Junco, 2012b	Undergraduates; USA	1,716	Frequency of Facebook multitasking in class	Documented GPA	-.02 (M)
27.	Junco, & Cotten, 2012	Undergraduates; USA	1,624	Frequency of Facebook multitasking with schoolwork	Documented GPA	-.06 (M)
28.	Karpinski et al., 2013 Sample 1	Undergraduates; USA	451	Time spent on SNS; SNS multitasking	Self-reported GPA	-.61 (G) -.28 (M)
29.	Karpinski et al., 2013 Sample 2	Undergraduates; EU	406	Time spent on SNS; SNS multitasking	Self-reported GPA	-.27 (G) .01 (M)

30.	Khan, Wohn, & Ellison, 2014	Adolescents; USA	690	Frequency of Facebook use; Several Facebook variables (including Number of Facebook friends ^e); Intensity of academic Facebook collaboration	Self-reported grades	.02 (G) .02 (A)
31.	Lampe et al., 2011	Undergraduates; USA	302	Facebook use for collaboration	Self-reported GPA ^a	-.01 (A)
32.	Lee, 2016	Undergraduates; Philippines	3,173 ^f	Time spent on Facebook	Self-reported GPA	-.02 (G)
33.	Leelathakul, & Chaipah, 2013	Adolescents; Thailand	98	Multi-item measure of Facebook use (use for academic purposes; use for non-academic purposes)	Documented GPA ^a	-.10 (G) .17 (A)
34.	Leung, 2015	Adolescents; Hong Kong	718	Frequency of Facebook use	Self-reported overall grades	.10 (G)
35.	Michikyan, Subrahmanyam, & Dennis, 2015	Undergraduates; USA	256-261 ^d	Time spent on Facebook; composite of Facebook activities	Self-reported GPA	.11 (G)
36.	Moon, 2011	Undergraduates; USA	204	Time spent on Facebook (several activities)	Self-reported GPA	-.13 (G)
37.	Negussie, & Ketema, 2014	Undergraduates; Ethiopia	394	Time spent on Facebook; Frequency of Facebook use	Self-reported GPA ^a	.28 (G)
38.	Ng et al., 2014	Adolescents; Malaysia	137	Time spent on Facebook	Documented GPA	-.02 (G)
39.	O'Brien, 2011	Undergraduates; USA	160	Time spent on Facebook; Frequency of Facebook use	Documented GPA	.06 (G)
40.	Ogedebe, Emmanuel, & Musa, 2012	Undergraduates; Nigeria	122	Time spent on Facebook	Self-reported GPA	.03 (G)
41.	Olufadi, 2015	Undergraduates; Nigeria	286	Time spent on SNS	Self-reported GPA	-.11 (G)

42.	Ozer, 2015 Pilot study Sample 1	Undergraduates; USA	444	Time spent on SNS; Frequency of SNS use; SNS multitasking	Self-reported GPA	-.46 (G) -.36 (M)
43.	Ozer, 2015 Pilot study Sample 2	Undergraduates; EU	346	Time spent on SNS; Frequency of SNS use; SNS multitasking	Self-reported GPA	-.15 (G) .00 (M)
44.	Ozer, 2015 Main study sample 1	Undergraduates; USA	226	Time spent on SNS; Frequency of SNS use; SNS multitasking; SNS use for school	Self-reported GPA	-.13 (G) .02 (M) -.01 (A)
45.	Ozer, 2015 Main study sample 2	Undergraduates; Turkey	200	Time spent on SNS; Frequency of SNS use; SNS multitasking; SNS use for school	Self-reported GPA	-.11 (G) -.10 (M) .01 (A)
46.	Pasek, More, & Hargittai, 2009 Sample 1 ^g	Undergraduates; USA	1,049	Frequency of Facebook use	Self-reported GPA	.01 (G)
47.	Pasek, More, & Hargittai, 2009 Sample 2 ^h	Undergraduates; USA	660	Frequency of Facebook use	Self-reported GPA	.12 (G)
48.	Ravizza, Hambrick, & Fenn, 2014	Undergraduates; USA	167	Multi-item measure of Facebook use (time spent and frequency)	Documented exam grade	-.10 (G)
49.	Rosen, Carrier, Cheever, 2013	Adolescents and Undergraduates; USA	263	Facebook multitasking (Use Facebook at least once in a 15 minute period on task/studying)	Self-reported GPA	-.23 (M)
50.	Rouis, 2012	Undergraduates; Tunisia	161	Multi-item measure of Facebook use (time spent, frequency and cognitive absorption)	Self-reported GPA	.10 (G)
51.	Rouis, Limayem, Salehi-Sangari, 2011	Undergraduates; Sweden	239	Multi-item measure of Facebook use (time spent and frequency)	Self-reported GPA	-.14 (G)
52.	Sendurur, Sendurur, & Yilmaz, 2015	Undergraduates; Turkey	406	Time spent on SNS	Self-reported GPA	-.23 (G)

53.	Sereetrakul, 2013	Undergraduates; Thailand	251	Time spent on Facebook; Facebook use for collaboration	Self-reported GPA	-.12 (G) .07 (A)
54.	Sinafar, Faridi, & Karamipour, 2016	Adolescents; Iran	103	Time spent on SNS	Self-reported GPA	-.01 (G)
55.	Swang, 2011	Adolescents; USA	130	Time spent on SNS	Self-reported GPA	-.10 (G)
56.	Walsh et al., 2013	Undergraduates; USA	483	Time spent on SNS	Self-reported GPA	-.06 (G)
57.	Wang, 2013	Undergraduates; Taiwan	134	Multi-item measure of Facebook use (Facebook games and non-gaming applications); Starting (school- related) projects on Facebook	Self-reported grades	-.22 (G) .35 (A)
58.	Yang et al., 2015	Undergraduates; USA	394	Number of Facebook friends; Number of Twitter Followers and Followings	Self-reported GPA	-.03 (G)
59.	Yu et al., 2010	Undergraduates; Hong Kong	187	Multi-item measure of SNS use (Time spent, number of friends)	Self-reported GPA	-.02 (G)

Notes. The studies were included in one, two, or all three meta-analyses: Effect size and (G) = included in meta-analysis on general SNS-use, effect size and (M) = included in meta-analysis on SNS multitasking, effect size and (A) = included in meta-analysis on SNS use for academic purposes. ^a Academic achievement measure not explicitly specified, but could be correctly categorized with a high probability; ^b Subgroup that used Twitter; ^c Whole sample, ^d Differences because of missing data; ^e Also included Facebook friends' instrumental support; Facebook class-related academic collaboration; ^f Results reported for $N = 1,495$ men and $N = 1,678$ women ^g University of Illinois at Chicago sample; ^hNASY (National Annenberg Survey of Youth), cross-sectional.

Table 2.

Meta-Analyses for Different Types of SNS Use

	Average Effect					Heterogeneity						
	<i>k</i>	<i>N</i>	Effect Size (<i>p</i>)	95% CI	<i>Z</i>	<i>p</i>	<i>Q</i>	<i>df</i> (<i>Q</i>)	<i>p</i>	<i>I</i> ²	<i>τ</i> ²	<i>SE</i> _{<i>τ</i>²}
General SNS use and												
Academic achievement	55	25,432	-0.071	[-.121; -.020]	-2.73	.006	805.95	54	<.001	93.30	.033	.009
Learning time	10	3,130	-0.025	[-.109; -.059]	-0.58	.562	48.68	9	<.001	81.51	.015	.009
Multitasking SNS use and												
Academic achievement	15	7,615	-0.103	[-.161; -.045]	-3.46	.001	83.40	14	<.001	83.21	.010	.006
SNS use for academic purposes and												
Academic achievement	10	2,589	0.075	[.015; .135]	2.45	.014	19.37	9	.022	53.53	.005	.004
Learning time and												
Academic achievement	14	5,015	0.153	[.057; .246]	3.12	.002	146.14	13	<.001	91.10	.030	.015

Table 3.

Moderator Analyses for General SNS Use and Academic Achievement

Variable	K	Between-groups analysis	Subgroup Effect Size	By Group Analysis
Publication type		Q (1) = 1.642, $p = .200$		
Published	35		$\hat{\rho} = -.05$, 95% CI [-0.12, 0.02], $Z = -1.45$, $p = .147$	Q (34) = 680.12, $p < .001$
Unpublished	20		$\hat{\rho} = -.11$, 95% CI [-0.18, -0.04], $Z = -3.21$, $p = .001$	Q (19) = 112.35, $p < .001$
Developmental status		Q (2) = 0.641, $p = .726$		
Very high developed countries	36		$\hat{\rho} = -.08$, (95%CI = -0.14; -0.03, $Z = -2.89$, $p = .004$)	Q (35) = 396.45, $p < .001$
High developed countries	10		$\hat{\rho} = -.09$, (95%CI = -0.18; -0.01, $Z = -2.08$, $p = .038$)	Q (9) = 41.22, $p < .001$
Medium and low developed countries ^a	9		$\hat{\rho} = -.01$, (95%CI = -0.20; 0.19, $Z = 0.06$, $p = .949$)	Q (8) = 365.89, $p < .001$
Academic achievement measure		Q (1) = 7.226, $p = .007$		
Self-reported achievement	41		$\hat{\rho} = -.09$, (95%CI = -0.15; -0.03, $Z = -2.72$, $p = .007$)	Q (40) = 772.09, $p < .001$
Documented achievement	14		$\hat{\rho} = .01$, (95%CI = -0.02; 0.04, $Z = 0.52$, $p = .604$)	Q (13) = 9.24, $p = .755$
Type of effect size		Q (1) = 7.273, $p = .007$		
Correlation	41		$\hat{\rho} = -.11$, (95%CI = -0.17; -0.05, $Z = -3.48$, $p = .001$)	Q (40) = 538.73, $p < .001$
Regression weight	14		$\hat{\rho} = .03$, (95%CI = -0.05; 0.11, $Z = 0.75$, $p = .453$)	Q (13) = 170.05, $p < .001$

Sample type		Q (1) = 4.678 , p = .031		
Adolescents	11		$\hat{\rho} = .01$, (95%CI = -0.05; 0.06, Z = 0.232, p = .817)	Q (10) = 21.57, p = .017
Undergraduates ^b	44		$\hat{\rho} = -.08$, (95%CI = -0.14; -0.02, Z = -2.66, p = .008)	Q (43) = 744.73, p < .001

Notes. ^ak = 2 medium developed countries, k = 7 low developed countries; ^bIncludes one sample consisting undergraduates and other adults

Table 4.
Moderator Analyses for Multitasking SNS use and Academic Achievement

Variable	K	Between-groups analysis	Subgroup Effect Size	By Group Analysis
Publication type		Q (1) = 0.006, $p = .938$		
Published	10		$\hat{\rho} = -.10$, (95%CI = -0.16; -0.05, Z = -3.57, $p < .001$)	Q (9) = 40.04, $p < .001$
Unpublished	5		$\hat{\rho} = -.09$, (95%CI = -0.27; 0.09, Z = -1.02, $p = .306$)	Q (4) = 39.46, $p < .001$
Region		Q (1) = 0.002, $p = .963$		
Very high developed countries	14		$\hat{\rho} = -.10$, (95%CI = -0.16; -0.04, Z = -3.30, $p = .001$)	Q (13) = 83.38, $p < .001$
High developed countries	1		$\hat{\rho} = -.10$, (95%CI = -0.24; 0.04, Z = -1.41, $p = .159$)	
Academic achievement measure		Q (1) = 0.957, $p = .328$		
Self-reported achievement	8		$\hat{\rho} = -.13$, (95%CI = -0.24; -0.02, Z = -2.23, $p = .026$)	Q (7) = 60.29, $p < .001$
Documented achievement	7		$\hat{\rho} = -.07$, (95%CI = -0.11; -0.03, Z = -3.29, $p = .001$)	Q (6) = 10.39, $p = .109$
Type of effect size		Q (1) = 0.033, $p = .855$		
Correlation	8		$\hat{\rho} = -.10$, (95%CI = -0.22; 0.02, Z = -1.68, $p = .092$)	Q (7) = 59.96, $p < .001$
Regression weight	7		$\hat{\rho} = -.09$, (95%CI = -0.14; -0.04, Z = -3.54, $p < .001$)	Q (6) = 16.86, $p = .010$

Sample type	Q (1) = 3.717 , p = .054	
Undergraduates	14	$\hat{\rho} = -.10$, (95%CI = -0.16; - 0.04, Z = - 3.10, p = .002) Q (13) = 78.23, p < .001
Mixed sample	1	$\hat{\rho} = -.23$, (95%CI = -0.34; -0.11, Z = - 3.69, p < .001)

Table 5.

Moderator Analyses for SNS use for Academic Purposes and Academic Achievement

Variable	K	Between-groups analysis	Subgroup Effect Size	By Group Analysis
Publication type		Q (1) = .687, p = .407		
Published	5		$\hat{\rho} = .10$, (95%CI = - 0.00; 0.20, Z = 1.92, p = .055)	Q (4) = 16.40, p = .003
Unpublished	5		$\hat{\rho} = -.05$, (95%CI = -0.02; 0.12, Z = 1.37, p = .172)	Q (4) = 2.70, p = .609
Region		Q (1) = 0.021, p = .886		
Very high developed countries	7		$\hat{\rho} = .08$, (95%CI =-0.00; 0.16, Z = 1.91, p = .056)	Q (6) = 17.63, p = .007
High developed countries	3		$\hat{\rho} = -.07$, (95%CI = -0.02; 0.15, Z = 1.61, p = .107)	Q (2) = 1.70, p = .428
Academic achievement measure		Q (1) = 1.202, p = .273		
Self-reported achievement	7		$\hat{\rho} = -.06$, (95%CI = -0.01; 0.14, Z = 1.62, p = .105)	Q (6) = 16.27, p = .012
Documented achievement	3		$\hat{\rho} = .13$, (95%CI = 0.04; 0.21, Z = 2.82, p = .005)	Q (2) = 0.539, p = .764
Type of effect size		Q (1) = 1.229, p = .268		
Correlation	8		$\hat{\rho} = .09$, (95%CI = 0.02; 0.16, Z = 2.37, p = .018)	Q (7) = 17.57 p = .014
Regression weight	2		$\hat{\rho} = .03$, (95%CI = -0.06; 0.11, Z = 0.64, p = .526)	Q (1) = 0.96, p = .327

Sample type		$Q(1) = 0.020, p = .886$	
Adolescents	2	$\hat{\rho} = .07, (95\%CI = -0.08; 0.21, Z = 0.91, p = .363)$	$Q(1) = 2.12, p = .146$
Undergraduates	8	$\hat{\rho} = .08, (95\%CI = 0.01; 0.15, Z = 2.13, p = .033)$	$Q(7) = 16.49, p = .021$

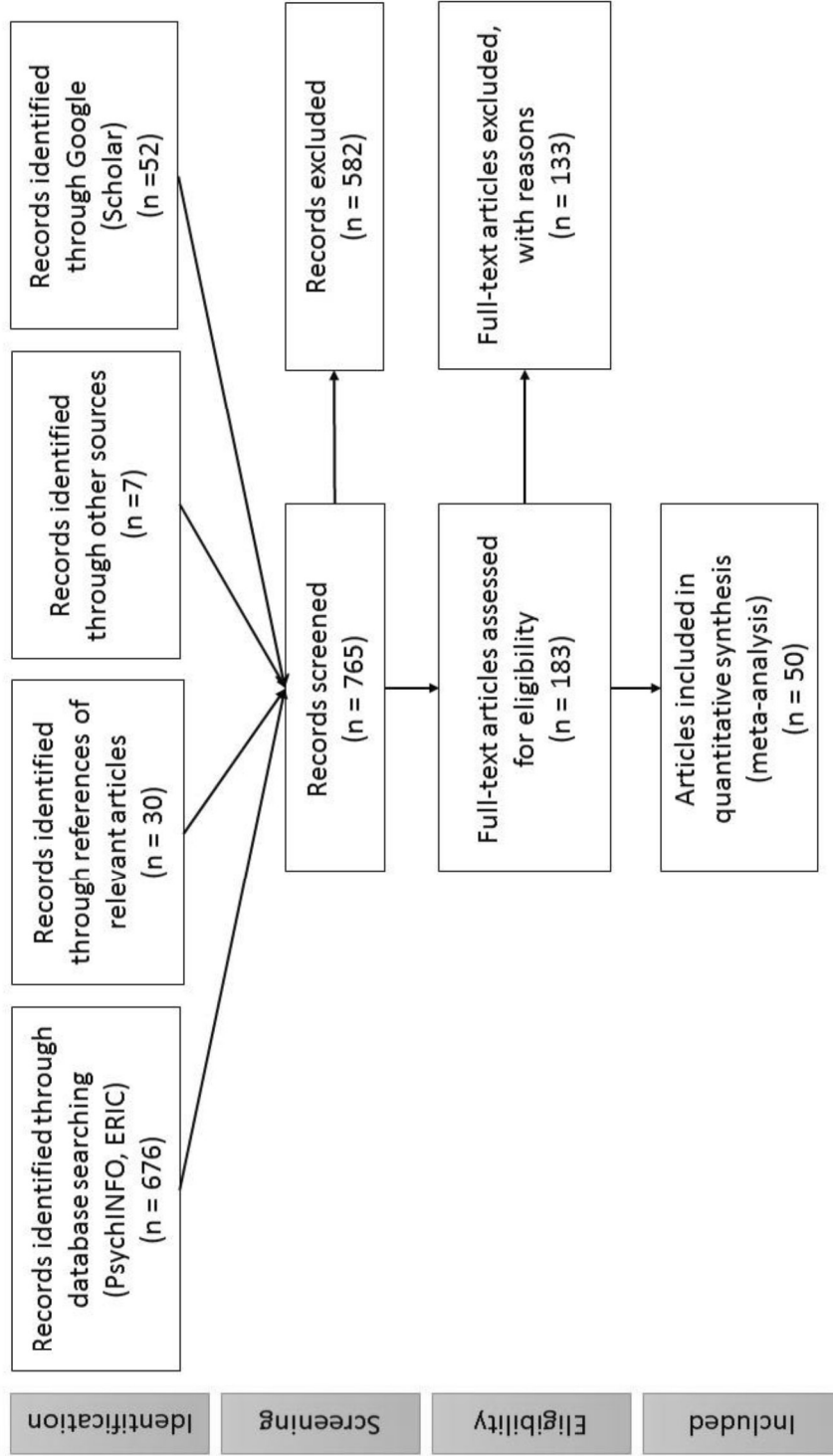


Figure 1. Flowchart of the literature search process.

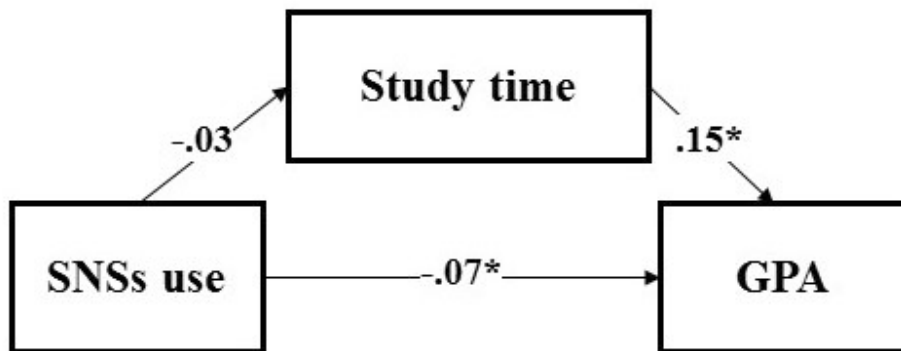


Figure 2. Meta-analytic test of the time displacement hypothesis. Standardized regression parameters ($*p < .05$) are presented.

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**Exploring the myth of the chubby gamer:
A meta-analysis on sedentary video gaming and body mass**

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Abstract

Rationale. High body mass and obesity are frequently linked to the use of sedentary media, like television (TV) or non-active video games. Empirical evidence regarding video gaming, however, has been mixed, and theoretical considerations explaining a relationship between general screen time and body mass may not generalize to non-active video gaming. *Objective.* The current meta-analysis had two main goals. First, we wanted to provide an estimate of the average effect size of the relationship between sedentary video gaming and body mass. In doing so we acknowledged several context variables to gauge the stability of the average effect. Second, to provide additional evidence on processes, we tested the displacement effect of physical activity by video gaming time with the help of a meta-analytic structural equation model. *Method.* Published and unpublished studies were identified through keyword searches in different databases and references in relevant reports were inspected for further studies. We present a random-effects, three-level meta-analysis based on 20 studies (total $N = 38,097$) with 32 effect sizes. *Results.* The analyses revealed a small positive relationship between non-active video game use and body mass, $\hat{\rho} = .09$, 95% CI [.03, .14], indicating that they shared less than 1% in variance. The studies showed significant heterogeneity, $Q(31) = 593.03$, $p < .001$, $I^2 = 95.13$. Moderator analyses revealed that the relationship was more pronounced for adults, $\hat{\rho} = .22$, 95% CI [.04, .40], as compared to adolescents, $\hat{\rho} = .01$, 95% CI [-.21, .23], or children, $\hat{\rho} = .09$, 95% CI [-.07, .25]. Meta-analytic structural equation modeling found little evidence for a displacement of physical activity through time spent on video gaming. *Conclusion.* These results do not corroborate the assumption of a strong link between video gaming and body mass as respective associations are small and primarily observed among adults.

Keywords: video gaming, online gaming, body mass, body weight, meta-analysis

Introduction

Next to TV, streaming media, and social networking sites, video gaming is one of the most popular pastime activities among adolescents and adults (Lenhart, Smith, Anderson, Duggan, & Perrin, 2015). A hobby reserved for computer geeks has turned into a multibillion-dollar industry, with a total of \$36 billion spent by consumers in 2017 (Entertainment Software Association, 2018). At the same time, worldwide obesity has nearly tripled in recent decades (World Health Organization, 2017). Given the health consequences of obesity, the debate on causes and correlates of overweight has gained momentum (e.g., Flegal, Kit, Orpana, & Graubard, 2013; Hobbs, Griffiths, Green, Christensen, & McKenna, 2019; Joslyn & Haider-Markel, 2019). Video gaming has been widely discussed as one leisure activity that is positively associated with body mass and overweight (e.g., Borland, 2011; Inchley, Currie, Jewell, Breda, & Barnekow, 2017; Mazur et al., 2018). Empirical findings on the popular form of non-active video games (i.e., games that are played while sitting in front of a screen, sedentary video games), however, have been mixed. While some studies found positive associations between the intensity of playing sedentary games and indicators of overweight, such as body mass index (BMI) (Martinovic et al., 2015; Siervo, Cameron, Wells, & Lara, 2014), others found no relationship (e.g., Bickham, Blood, Walls, Shrier, & Rich, 2013; Scharrer & Zeller, 2014). Given these conflicting findings and the substantial interest in the topic by parents, teachers, health professionals, legislators, and the general public, our aim was to provide a meta-analytic summary on the relationship between playing non-active video games and body mass.

General Screen Time and Body Mass

Media use is often blamed for causing overweight, especially the use of screen-based media, like TV and video gaming (cf. Hingle & Kunkel, 2014; Rogers, 2016). Most previous studies did not differentiate between video gaming and TV or other screen-based leisure activities. General screen time was found to be a predictor of higher body mass in a number of studies (Banks, Jorm, Rogers,

Clements, & Bauman, 2011; Buchanan et al., 2016; Maher, Olds, Eisenmann, & Dollman, 2012; Mitchell, Rodriguez, Schmitz, & Audrain-McGovern, 2013), but the available evidence summarized in systematic reviews is still somewhat inconclusive. Whereas Marshall, Biddle, Gorely, Cameron, and Murdey (2004), as well as Foulds, Rodgers, Duncan, and Ferguson (2015) identified a significant relationship between TV viewing and indicators of fat mass among children and youth, others found no substantial associations (Chinapaw, Proper, Brug, van Mechelen & Singh, 2011; van Ekris et al., 2016). Importantly, there is a lack of recent meta-analytic evidence for links between body mass and specific screen-based activities other than TV use.

Several mechanisms are discussed that might explain the potential relationship between body mass and screen time. First, physical activities may be displaced by the time spent with sedentary media use, resulting in lower energy expenditure (e.g., Buchanan et al., 2016; Robinson et al., 2017). A second mechanism is increased energy intake due to consuming high caloric foods and drinks in front of the screen (e.g., Ford, Ward, & White, 2012; Pearson & Biddle, 2011). Third, researchers have argued that the influence of screen time on eating and drinking behavior is due to the effects of advertising for high-calorie products (Binder, Naderer, & Matthes, 2019; Harris, Bargh, & Brownell, 2009; McGinnis, Gootman, & Kraak, 2006; Robinson & Matheson, 2015). A fourth link between screen time and body mass could be sleep. Higher amounts of screen time were found to be associated with shorter sleep duration (Hale & Guan, 2015). Sleep deprivation, in turn, may cause weight gain due to hormone changes, stronger feelings of hunger, more frequent choices for high calorie foods, and snacks between mealtimes (Fatima, Doi, & Mamun, 2015; Miller, Lumeng, & LeBourgeois, 2015; Magee & Hale, 2012). Finally, reversing the causal perspective, the relative attractiveness of screen media may increase with an individual's body mass, as alternative activities such as sports and other social activities appear more demanding and less attractive due to physiological and psychological challenges.

A Special Case for Video Gaming?

The literature on screen time is heavily based on TV as the oldest screen medium. Usage patterns, however, have shifted towards computer-based activities (e.g., Inchley et al., 2017) and mechanisms discussed as underlying the screen time – body mass linkage might apply differently to video games. TV and video games are two different activities and there are some theoretical considerations that might explain diverging relationships between body mass and video gaming versus body mass and general screen time/TV.

First, evidence on the time displacement hypothesis is inconclusive for video gaming (Pearson, Braithwaite, Biddle, van Sluijs, & Atkin, 2014), thus, it remains unclear whether the time spent on playing video games comes at the expense of offline activities, such as sports. Second, despite the sedentary nature, playing video games can be more activating than watching TV. People playing sedentary video games showed higher energy expenditure than people resting (Barkley & Penko, 2009; Lanningham-Foster et al., 2006; Penko & Barkley, 2010; Wang & Perry, 2006). Third, console and computer games usually contain less advertising for unhealthy foods than TV fare (Leibowitz, Rosch, Ramirez, Brill, & Ohlhausen, 2012). Finally, eating and drinking high caloric food and beverages in front of the screen might be less prevalent with video games, as most popular sedentary video games require constant actions by both hands (Rey-Lopez, Vicente-Rodriguez, Biosca, & Moreno, 2008; Tomlin et al., 2014).

The Current Meta-Analysis

At present, there is no meta-analytic summary available that explicitly focuses on sedentary video gaming and body mass. In their review, Marshall and colleagues (2004) examined media use and body mass in general terms. Six of the studies included in their meta-analysis reported on the relationship between video gaming and body mass, the meta-analyzed average effect of these six studies was not significant. Video gaming has become a lot more popular since 2002 (the most

recent publication year for studies included by Marshall et al., 2004), resulting in a large number of new studies that have yet to be systematically summarized. The diverging results of primary studies and the potential differences regarding mechanisms call for a new and more detailed view on the relationship between non-active, sedentary video games – the most popular form of video games by far – and body mass. Note that we do not focus on active video games (e.g., *Wii sports* or *Dance Dance Revolution*), which are non-sedentary per definition, and might contribute to lower, rather than higher body mass (Gao, Chen, Pasco, & Pope, 2015; Mack et al., 2017; Staiano, Abraham, & Calvert, 2013). The current meta-analysis had two goals. First, we wanted to provide an estimate of the average effect size of the relationship between body mass and video gaming that includes recent research from the last one and a half decades. More importantly, we acknowledged several context variables to gauge the stability of the average effect (we had no a priori hypotheses on the direction of these effects). Second, to provide additional evidence on processes, we tested the displacement effect of physical activity by video gaming time with the help of a meta-analytic structural equation model (MASEM; Cheung & Hong, 2017). We hypothesized that video gaming was related to less physical activity and physical activity was, in turn, expected to be negatively related to body mass.

Method

Meta-Analytic Database

Search process. Relevant studies published until June 2018 were identified by searching the PsycINFO, MEDLINE, and ProQuest databases combining the search terms “obes*”, “overweight”, “fat*”, “corpulent”, “adipos*”, “body mass”, “body composition”, and “weight” with “online gam*”, “facebook gam*”, “video gam*”, and “computer gam*” (detailed information is available in the online supplement). Grey literature, such as unpublished reports, conference proceedings, or theses were identified in Google Scholar and ProQuest Dissertation Abstracts. Additional studies

were retrieved from the references of all relevant reports (see Figure 1). This process resulted in 753 potentially relevant studies.

Inclusion criteria. Studies were included in the meta-analysis if they met the following criteria: the study contained (a) a measure of body mass (i.e., body mass index, body fat percentage, waist circumference, or subscapular skinfold thickness), (b) a measure of video game use (e.g., frequency or duration of video game sessions), (c) data on their zero-order relationship (or respective statistics that could be used to approximate this relationship), and (d) the sample size. Moreover, the language of the study report needed to be English, German, or French. The meta-analysis addressed sedentary video gaming; thus, we excluded studies on active video games such as *Wii Sports*, studies that reported on screen time (which represents a mix of TV, video gaming, and computer/Internet use), on general media use, on unspecified Internet use, or on unspecified computer use (e.g., Hesketh, Wake, Graham, & Waters, 2007). No restrictions were placed on country, date of publication, study design, participant age, gender, or other demographics. From a total of 753 reports, through their titles and abstracts, we identified 160 possibly relevant reports, and then inspected the full papers. We contacted all authors who had provided studies that could have been eligible but contained partial relationships only (e.g., as part of a multiple regression analysis or as adjusted odds ratios). After applying all eligibility criteria, 20 publications met our criteria and were included in the meta-analysis (see Table S1).

Coding process. A coding protocol (see supplemental material) summarized all relevant information including the definition of each variable, the range of potential values, and examples for each coding step. The first author and a student assistant independently extracted the relevant data (i.e., effect sizes, descriptive information, moderator variables) from each publication. The focal effects were the zero-order relationships between video gaming and body mass. For analyses on a possible mediating effect of physical activity, we also coded effects on the association between

physical activity with body mass and video gaming. For studies that did not report respective correlation coefficients, we extracted any relevant statistics (e.g., odds ratio) that could be transformed into correlation coefficients. The inter-coder agreement for the coded effect sizes was 100% (Krippendorff's, 1970, $\alpha = 1.00$).

To evaluate the robustness of the meta-analytic results (including moderator analyses), we coded several variables: (a) publication year, (b) age group, (c) gender ratio in the sample, (d) the type of body mass measurement, (e) preexisting gender differences in body mass, and (f) indicators for a quality assessment. Due to frequently missing information on the mean age of the sample, we coded three age categories: children (up to 11 years old), adolescents (12 to 19 years old), and adults (mostly undergraduates). We further coded the operationalization of video gaming and body mass. Video gaming was coded in one of three categories: (1) time for video gaming absolute (i.e., hours/day), (2) subjective general intensity, and (3) frequency of gaming (i.e., number of sessions). Because nearly all studies measured time spent with video games, this variable was not included in our moderator analyses. The body mass measure was coded in one of six categories: (1) self-reported continuous BMI, (2) self-reported BMI that was dichotomized, (3) objective continuous BMI, (4) objective dichotomized BMI, (5) objective continuous non-BMI measures (percent fat mass through skinfold thickness, bioelectrical impedance analysis, or waist circumference), and (6) dichotomized non-BMI measures. Additionally, we coded information on the association between gender and body mass (converted into Cohen's *d*). If this indicator predicted the association between video gaming and body mass, this would have highlighted the possibility of gender explaining the link between video gaming and body mass, given that video gaming is typically more common in males. With a modified version of the *Quality Assessment Tool for Quantitative Studies* (Thomas, Ciliska, Dobbins, & Micucci, 2004) we rated each study's quality in three sections: selection bias, disclosure of study's participants, and data collection methods (1 = *high*

quality; 2 = medium quality; 3 = low quality). The mean of the three section ratings was computed to form a global quality rating for each study. The respective interrater reliability between the two coders for the global rating was $\alpha = .56$. This value was based on the ratings for 29 studies, including the studies that reported zero-order correlations ($k = 20$) and additional studies that reported adjusted odds ratios ($k = 9$). All differences could be resolved unanimously.

Meta-Analytic Procedure

The meta-analysis was conducted following the guidelines of the *Preferred Reporting Items for Systematic Reviews and Meta-Analyses* (PRISMA, Moher et al., 2015) as well as standard procedures and recommendations for the social and medical sciences (Lipsey & Wilson, 2001).

Effect size. The Pearson product moment correlation was our primary effect size. A positive correlation coefficient indicates that more video game use (or being a video game player as compared to not being a video game player) is associated with higher body mass. Because some studies only reported odds ratios based on dichotomized measures (e.g., obesity groups based on BMI; see Table S1), a total of 15 odds ratios (46.88% of all effects) were transformed into correlations following Bonnett (2007). We decided to transform the odds ratios into correlations, rather than the other way around, to fit the nature of a linear relationship we expected between video gaming and body mass. This approach is prevalent in the meta-analytic literature (Gnambs & Appel, 2018; Grekin & O'Hara, 2014; Xu, Norton, & Rahman, 2018). We further distinguished between crude odds ratios (zero-order relationships) and adjusted odds ratios (second-order relationships) and excluded the latter from the analysis. Adjusted odds ratios as well as partial correlations are effect sizes that control for third variables (e.g., gender, general media use, education, age). Typically, the control variables differ between the studies and are not comparable. Therefore, effect sizes that adjust for different third variables reflect different partial effects and should not be pooled in common meta-analyses (e.g., Aloe, 2015; Roth, Le, Oh, Van Iddekinge, &

Bobko, 2018). Following a rather conservative approach (cf. Rothstein & Bushman, 2015), we decided to include only zero-order associations into our meta-analysis. We acknowledge that different opinions on the inclusion of adjusted odds ratios exist (cf. Aloe, Tanner-Smith, Becker, & Wilson, 2016). As a consequence, we provide an additional analysis that includes adjusted odds ratio data in the supplemental material. Moreover, residual analyses using the Cook's distance (cf. Viechtbauer & Cheung, 2010) identified one extreme effect size (i.e., an outlier) reported in Mwaikambo, Leyna, Killewo, Simba, and Puoane (2015). Because additional analyses excluding this effect did not result in different conclusions (see supplemental material), the effect size was included in the reported analyses.

Univariate meta-analyses. The effect sizes were pooled using a random effects model with a restricted maximum likelihood estimator (Viechtbauer, 2005). Because the precision of the population effects estimated in a given sample is a function of the sample size, meta-analyses aim at accounting for the differences in precision between samples. To account for this sampling error, the effect sizes were weighted by the inverse of their variances. In some studies, two or more associations between video game play and body mass were reported for one and the same sample (e.g., scores for two video gaming measures were each correlated with BMI). In these cases, all eligible associations were meta-analyzed. We accounted for the resulting dependencies by fitting a three-level meta-analysis to the data (Moeyaert et al., 2017; Van den Noortgate, López-López, Marín-Martínez, & Sánchez-Meca, 2013). The heterogeneity between studies ($\tau^{2.3}$) as well as between effect sizes ($\tau^{2.2}$) was statistically tested using the χ^2 -distributed Q -statistic (Cochran, 1954) and quantified by I^2 (Higgins, Thompson, Deeks, & Altman, 2003). Moderator analyses were performed using weighted, mixed-effects regression analyses. To evaluate the power of our meta-analysis and identify our a priori determined effects, we conducted power analyses for the pooled fixed effect (Jackson & Turner, 2017) and the moderating effects (Hedges & Pigott, 2004). The

meta-analytic models were estimated in *R* version 3.5.0 using the *metafor* package version 2.0-0 (Viechtbauer, 2010).

Moderator analyses. The variables for the possible moderating effects were included as follows: publication year was centered around the mean ($M = 2010.81$, $SD = 4.00$) and included as a continuous variable. For the age groups, the first two categories, children (up to 11 years old) and adolescents, were each compared to adults (undergraduates or mixed samples of adults) as the reference group. The percentage of females in the sample was centered around .50 and included in the analysis. For possible systematic gender differences in body mass, a sample-wise estimate of gender differences in body mass (converted into Cohen's d) was included as a continuous variable. Concerning the type of body mass measure, self-reported BMI (reference group) was first compared to objective BMI, and then to objective measures like body fat percentage and waist circumference. Additionally, we distinguished between effect sizes that were based on continuous body mass indicators such as BMI and effect sizes that were based on a dichotomization, such as the categories of overweight/obese or not overweight/obese. The quality indicator was also included as a continuous variable.

Due to a lack of reported information, three missing values were present in the gender ratio of the sample and 14 in the gender differences in body mass. Missing information on gender ratio was estimated with 50% females. For studies that did not report estimates of gender differences in body mass, the mean difference was chosen as the estimate.

Meta-analytic structural equation modeling (MASEM). A possible mediating effect of physical activity was examined using MASEM following two steps (see Cheung & Hong, 2017). First, three univariate meta-analyses were conducted that pooled either the relationship between video gaming and body mass, between video gaming and physical activity, or between physical activity and body mass. Then the pooled correlation matrix was subjected to a path analysis in

metaSEM version 1.1.0 (Cheung, 2015) using a weighted least squares estimator. As suggested by Cheung and Chan (2005), the asymptotic sampling covariance matrix of the pooled correlations was used as weight matrix for these analyses. Two regressions resulted from this procedure: body mass was regressed on video gaming and physical activity, and physical activity was regressed on video gaming. The significance of the indirect effects was evaluated using likelihood-based confidence intervals (Cheung, 2009).

Publication bias. Small-study bias was evaluated using funnel plots that visualized the observed effect sizes depending on their standard error (Stern, Egger, & Smith, 2001). Because smaller studies are more likely to yield negative or non-significant findings, these results have a greater propensity of remaining unpublished and, thus, yield an asymmetric funnel plot. Funnel plot asymmetry was investigated visually and by regressing the effect sizes on their standard errors (Stanley & Doucouliagos, 2014). A significant result can indicate systematically missing studies and, thus, the presence of publication bias. However, other explanations for funnel plot asymmetry are also possible (see Lau, Ioannidis, Terrin, Schmid, & Olkin, 2006).

Benchmarks for Interpretation. Empirical effect size distributions in psychology (Bosco, Aguinis, Singh, Field, & Pierce, 2015; Gignac & Szodorai, 2016) typically exhibit a median effect size around $r = .20$ (with the 25th and 75th percentiles around .10 and .30). Therefore, effects smaller than $r = .10$ can be considered small. Moreover, it is questionable whether context effects that explain less than 1 percent in variance of participants' health are clinically significant. We considered meta-analytic effects of at least $r = .10$ as small and practically relevant, whereas effects exceeding $r = .20$ were considered moderate. Similar thresholds are used to interpret moderating effects.

Following Higgins and colleagues (2003), we view values of $I^2 = .25, .50, \text{ and } .75$ as low, medium, and high heterogeneity, respectively. These cutoffs refer to the total heterogeneity (across

effect sizes and samples) and will be used to evaluate whether pronounced random variance is present. Because I^2 is a relative measure of heterogeneity, it does not inform about the predicted range of effects (Borenstein, Higgins, Hedges, & Rothstein, 2017). Therefore, we also compared the absolute heterogeneity in our meta-analysis to an empirical distribution of 188 heterogeneity estimates published between 1990 and 2013 in *Psychological Bulletin* (van Erp, Verhagen, Grasman, & Wagenmakers, 2017). This τ^2 distribution had a median of .026, with the 25th and 75th percentiles falling at .010 and .048. Therefore, we considered these values as indicators of moderate, small, or large heterogeneity, respectively.

Data and Code Availability

The coded data and the *R* scripts are provided in an online repository at osf.io/tb6un. The repository further includes a copy of the codebook, the modified quality assessment tool, the PRISMA checklist, and the supplemental material.

Results

Out of 20 publications with 24 samples (total $N = 38,097$) we included 32 effect sizes on the relationship between video gaming and body mass in the analyses. Six studies with ten samples reported more than one effect size, ranging from two to four effect sizes (see Table S1). The studies represented data of 18,669 (51.69%) females and 17,450 (48.31%) males (for a total $N = 36,119$ with information on gender ratios). Most studies investigated children ($k = 10$), only five studies investigated adolescents ($k = 5$) or adults ($k = 5$; mostly undergraduates). The mean age for studies with information on age was 15.27 ($SD = 11.35$; for $N = 18,004$ with information on mean age). Most studies were conducted in Europe ($k = 9$) and North America ($k = 8$); more specifically, the samples originated from the following countries (number of studies in parenthesis): Canada (2), France (2), Montenegro (1), Netherlands (1), New Zealand (1), Norway (1), Sweden (1), Spain (1), Switzerland (1), Tanzania (1), Thailand (1), United Kingdom (1), and United States (6). The

majority of the studies reported BMI as the indicator for body mass ($k = 16$). For video gaming, time spent on video gaming was assessed in most primary studies ($k = 16$).

Univariate Meta-Analysis

Across $k = 24$ samples and 32 effect sizes, the unweighted mean correlation was $r = .11$ ($SD = .15$). The average power of the included studies to identify a small effect ($r = .10$) or a moderate effect ($r = .20$) was .56 and .75, respectively. Thus, most individual studies were underpowered to identify the small effect that was expected based on prior research. After accounting for sampling error, the pooled effect of the relationship between video gaming and body mass was $\hat{\rho} = .09$, 95% CI [.03, .14] (Table 1). Hence, higher video gaming was positively associated with higher body mass. The power of the meta-analysis to identify a small or moderate effect was .98 and 1.00, respectively. This relationship was significant ($\alpha = .05$), but there remained significant total heterogeneity, $Q(31) = 593.03$, $p < .001$, $I^2 = 95.13$. This heterogeneity resulted mostly from differences between the studies, $I^{2.3} = 84.16$, $\sigma^{2.3} = .014$, rather than between the effect sizes, $I^{2.2} = 10.97$, $\sigma^{2.2} = .002$. Thus, about 84% of the observed variance in the effect sizes could be attributed to differences between the samples (e.g., participant characteristics, study procedures) rather than sampling error. However, the absolute heterogeneity estimate, $\sigma^2 = .016$, can be considered small to moderate as compared to typical meta-analyses in psychology (van Erp et al., 2017). Nevertheless, the observed heterogeneity underscored a need for further moderator analyses.

Moderator Analyses

To address the high heterogeneity between the effect sizes, we conducted additional analyses to examine the robustness of our findings (see Table 2). We included the following variables: (a) publication year, (b) age group, (c) gender ratio in the sample, (d) the type of body mass measurement, (e) gender differences in body mass, and (f) an indicator for a quality assessment. The moderator variables were included simultaneously in the moderator model due to

significant intercorrelations. We further conducted single moderator analyses that showed very similar results. These analyses along with correlations between the moderator variables are presented in the supplemental material.

The omnibus test for all moderators in the model was not significant, $F(9, 22) = 1.60, p = .176, R^2 = .27$. Yet, we found a significant moderation for the age groups; the omnibus test for age was $\chi^2 (df = 2) = 6.56, p = .038$. Compared to adults, adolescents showed a significantly lower relationship between video gaming and body mass, $B = -.21, 95\% \text{ CI } [-.38, -.04]$ for the moderation effect. The corresponding moderation effect for children versus adults was not significant, $B = -.13, 95\% \text{ CI } [-.30, .04]$; however, the test had a limited power to identify a medium (Power = .74) or small moderating effect (Power = .26). For adolescents the pooled effect was $\hat{\rho} = .01, 95\% \text{ CI } [-.21, .23]$ and, for children, the effect was $\hat{\rho} = .09, 95\% \text{ CI } [-.07, .25]$, whereas adults showed an effect of $\hat{\rho} = .22, 95\% \text{ CI } [.04, .40]$. For adults, this effect size indicates an increase of 0.22 standard deviations in body mass when video gaming increases by one standard deviation. Thus, our meta-analysis of zero-order relationships points out markedly different associations between video gaming and body mass for different age groups. Consistent with a previous meta-analytic summary by Marshall and colleagues (2004), we identified no significant association between video gaming and body mass among youth up to 18 years of age. Extending the previous meta-analytic evidence, we did, however, identify a significant association among adult samples.

Apart from the age group effect, the year of publication, the gender ratio in the sample, as well as gender differences in body mass had no significant influence on the relationship between video gaming and body mass. Moreover, the type of body mass measure, self-reported BMI versus objective measures like body fat percentage, and continuous versus dichotomous variables, as well as the quality of the studies showed no significant impact on our findings.

Because studies with small sample sizes or non-significant effects are often not published, we examined the funnel plot for a potential publication bias. The funnel plot (see supplemental material) was widely symmetric and the test for funnel plot asymmetry was not significant, $B = -0.58$, $SE = 1.43$, $t(30) = -0.41$, $p = .686$. Thus, there was no indication for a substantial publication bias.

Mediating Role of Physical Activity (MASEM Analysis)

We expected the amount of physical activity to mediate the effect of video gaming on body mass. Three univariate meta-analyses were conducted that quantified the associations between video gaming, body mass, and physical activity (Table 1). The pooled effect for the relationship between video gaming and body mass was previously estimated as $\hat{\rho} = .09$. The relationship between body mass and physical activity was estimated over $k_1 = 11$ independent samples with $k_2 = 37$ effect sizes. The pooled effect was significant with $\hat{\rho} = -.08$, 95% CI [-0.15, -.01]. Higher physical activity was associated with lower body mass. However, for $k_1 = 4$ independent samples with $k_2 = 14$ effect sizes, the average relationship between video gaming and physical activity was only marginally significant ($p = .074$) with $\hat{\rho} = -.08$, 95% CI [-0.17, 0.01]. This result should be interpreted with caution because of the small sample of primary studies.

Based on these pooled correlations, we estimated the mediation model presented in Figure 2. In line with the univariate meta-analyses, video gaming ($B = .08$, 95% CI [.02, .14]) and physical activity ($B = -.07$, 95% CI [-.14, -.00]) had significant associations with body mass, whereas video gaming showed only a marginally significant main effect on physical activity ($B = -.08$, 95% CI [-.16, .00]). The respective indirect effect was $B = .01$, 95% CI [.00, .02] and, thus, explained only 7 percent of the total effect of video gaming on body mass. These results suggest only a very modest displacement of physical activity through time spent on video gaming. Because of the small number

of samples, the results of this MASEM analysis need to be interpreted as preliminary, until they have been replicated with larger samples.

Discussion

In many regions worldwide stereotypes connect video gaming to overweight and obesity (Kowert, Griffith, & Oldmeadow, 2012). At the same time intense video gaming has been discussed in the scientific literature as contributing to higher body mass. Much of the available evidence on the link between media use and body mass is based on measures of general screen time (including TV use, gaming, and other computer-based activities), or TV use alone (cf. Marshall et al., 2004). We identified potential differences between TV and video games regarding mechanisms underlying the link to body mass, and we conducted a meta-analysis of cross-sectional, non-experimental studies. We summarized the available evidence on the relationship between non-active video gaming and body mass, excluding studies in which video game use was mingled with other screen-based activities. Our aim was to identify the magnitude of this association, and to take a closer look at several context variables as part of moderator analyses. Moreover, (reduced) physical activity was investigated as a potential mediator that might account for this relationship.

We found a significant positive relationship between video gaming and body mass ($\hat{\rho} = .09$). Individuals who spend more time with sedentary video games exhibit a higher body mass. Although this relationship was significant, the correlation was rather small in size, that is, less than 1% of an individual's body mass can be explained by the time spent with video gaming. This association was quite stable across a range of context variables. Out of seven investigated moderators, only age group turned out to be a significant moderator. Among studies that focused on adolescents and children, video gaming and body mass were not significantly correlated, whereas a significant relationship was identified for adult samples.

This meta-analytic result provides a substantial addition to the literature and points out the importance of age (and potentially birth cohort). With respect to age and gaming, as of 2018, around 90% of teens in Western societies play video games (Anderson & Jiang, 2018, for US data), whereas the percentage of young adults playing video games is substantially lower (60% of 18-29 year olds in the US, Brown, 2017). Video gaming appears to be a transient activity for many (cf. Rothmund, Klimmt, & Gollwitzer, 2018). In addition, the mechanisms underlying an increase in body mass operate long-term, rather than short-term. Thus, associations likely manifest themselves after a longer time-span of video gaming, leading to a higher likelihood of substantial correlations at an adult age. The size of the relationship for adults ($\hat{\rho} = .22$) is noteworthy. It is similar to effect sizes often found in applied psychological research. The average empirical association between attitudes and behavior, for example, revolves around $r = .16$ (Bosco et al., 2015).

Based on the available information in the primary studies, we conducted a MASEM to test an indirect effect of physical activity. We found a significant indirect effect, indicating that people who spend more time with video games exercised less and therefore had higher body mass (Figure 2). Because of the small number of included studies this result can only be interpreted as a hint to a possible indirect effect.

Limitations and Future Research

As meta-analyses are highly dependent on the quality of the available primary studies, there are some limitations to mention within this meta-analysis. First, many primary studies included different control variables: some studies acknowledged variables like age and gender, other studies included socioeconomic status or education level in addition to age and gender, while other studies controlled for specific variables like physical activity and energy intake. Because the choice of control variables results in different partial effects for the association between video gaming and body mass, we followed prevalent recommendations (Aloe, 2015; Roth et al., 2018; Rothstein &

Bushman, 2015) and focused on unadjusted effect sizes reflecting zero-order relationships.

Although this allowed us to pool similar effects across studies, the analysis of zero-order associations could obfuscate the systematic influence of third variables. In primary studies, adjusting associations from the influence of control variables (such as gender) likely reduces the size of the focal association. Thus, we would expect smaller associations in a meta-analysis based on adjusted effect sizes. Supplementary analyses were conducted in which additional studies that reported adjusted effect sizes were included (see Table S3). However, the average association remained virtually unchanged. Second, the primary studies our analysis was based on are cross-sectional studies that do not allow causal interpretations. Is it the amount of time spent with non-active video games that causes weight gain or do people with higher body mass play video games more intensively because of lower physical fitness? This question cannot be answered by our findings. Nevertheless, a significant correlation is the minimum requirement for causality.

Available longitudinal studies point to an effect of screen time on body mass rather than an effect of existing overweight on screen time later on (Berkey et al., 2002; Gordon-Larsen, Adair, & Popkin, 2002). Even though there is evidence for sedentary behavior to influence weight gain, the effect sizes in these longitudinal studies, as well as in our meta-analytic summary, are rather small. Thus, the association between non-active video gaming and body mass needs serious attention without scandalizing headlines by the popular press. Third, our meta-analysis identified some heterogeneity between the primary studies. Although we conducted moderator analyses, these explained only part of the between-study variance. Thus, additional factors our meta-analysis could not elucidate seem to have influenced the observed gaming-body mass association. This includes the actual games and genres that are preferred by gamers (too few studies provided such information). Games or even genres may differ in several potentially relevant characteristics, such as the stress evoked or in-game food advertising (cf. Terlutter & Capella, 2013). Very few studies reported separate effect

sizes for men and women, therefore moderator analyses regarding the influence of participants' gender were based on the proportion of female participants in a given sample.

Fourth, several mechanisms have been discussed as underlying the video game-body mass association. Our results indicated that physical activity might be a mediating factor. However, because of the small effect, other mediators such as reduced sleep due to computer gaming prior to bedtime (e.g., Kuss & Griffiths, 2012; Sun, Sekine, & Kagamimori, 2009) need to be examined in the future. Last, it is likely that our set of primary studies does not include all of the empirical findings on video gaming and body mass. Although we followed the recommended literature search process and searched directly for unpublished data, our meta-analysis did not include grey literature. However, our analysis of a possible publication bias indicated no systematically missing studies.

Our literature search revealed that empirical research on the link between playing non-active video games and obesity is quite rare. Much of the research in the field is focused on TV use or no distinction between different screen media is made. In contrast to the rather little attention that non-active video games received, research on active video games has prospered in recent years (cf. Gao et al., 2015). Given the high popularity of sedentary video games for boys and girls, men and women (the unprecedented popularity of the battle royale game *Fortnite* is a point in case), non-active video gaming deserves more scholarly attention.

Conclusion

This meta-analysis investigated the relationship between non-active (sedentary) video gaming and body mass, contributing to the research literature on the behavioral correlates of overweight and obesity. We identified a small significant correlation between video gaming and body mass overall. This relationship was qualified by participants' age. The focal association was identified for adult samples, but there was no significant association for samples of children or

adolescents. Based on a smaller subset of primary studies, we found a small indirect effect on body mass, indicating a displacement of physical activity by video gaming. In summary, sedentary video gaming is only weakly associated with body mass, physical activity might play a mediating role, and the relationship varies with participants' age.

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Table 1. Univariate Meta-Analyses

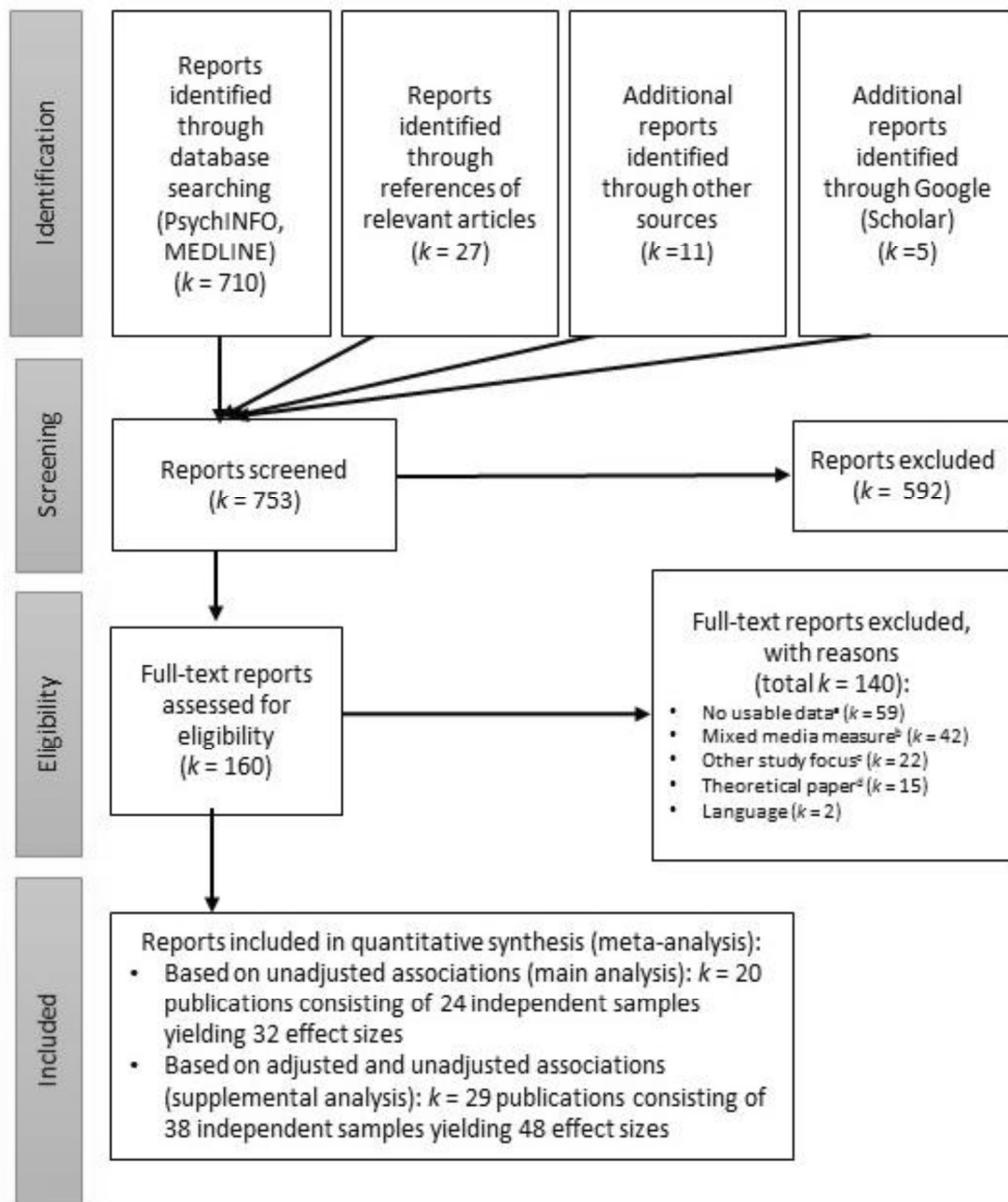
		Average Effect				Heterogeneity						
k_1/k_2	N	Effect Size (p)	95% CI	(df) t	Q	df (Q)	p	I^2	I^2	$\sigma^{2.3}$	$\sigma^{2.2}$	
Video Gaming and												
Body Mass	20/32	38,097	0.086	[.026; .145]	(31) 2.94	593.03	31	<.001	84.16	10.97	.014	.002
Video Gaming and												
Physical Activity	4/14	3,864	-0.080	[-.168; .009]	(13) -1.95	47.44	13	<.001	36.26	38.63	.003	.004
Physical Activity												
and												
Body Mass	11/37	20,582	-0.077	[-.143; -.010]	(36) -2.27	765.51	36	<.001	12.66	83.35	.003	.021

Notes. k_1 = Number of studies; k_2 = Number of effect sizes; I^2 = level 3 heterogeneity between studies; I^2 = level 2 heterogeneity between effect sizes $\sigma^{2.3}$ = level 3 variance between studies, $\sigma^{2.2}$ = level 2 variance between effect sizes.

Table 2. Moderator Analyses

Variable	<i>B</i>	95% <i>CI</i>	<i>SE</i>	<i>t</i>	<i>p</i>	Power _s	Power _m
Intercept	.30	[-.07, .66]	.18	1.66	.111		
Publication Year ^a	.01	[-.00, .03]	.01	1.66	.112	.93	>.99
Age Group							
Adults vs. Children ^{c,d}	-.13	[-.30, .04]	.08	-1.61	.122	.26	.74
Adults vs. Adolescents ^{c,d}	-.21	[-.38, -.04]	.08	-2.54	.019	.24	.71
Gender ratio in sample ^{a,b}	.01	[-.08, .10]	.04	0.21	.834	.92	>.99
Gender differences in body mass	.04	[-.60, .68]	.31	0.11	.910	.77	>.99
Body Mass Measure							
Self-reported BMI vs objective BMI ^{c,e}	.05	[-.08, .18]	.06	0.84	.410	.38	.91
Self-reported BMI vs. other measures ^{c,e}	.06	[-.11, .23]	.08	0.77	.449	.20	.60
Continuous vs. dichotomous body mass measures ^{c,f}	.02	[-.13, .16]	.07	0.26	.797	.31	.83
Study Quality Index	-.07	[-.25, .11]	.09	-0.80	.434	.79	>.99
$\sigma^{2.3} / \sigma^{2.2}$	0.009 / 0.003						
k_1 / k_2	20 / 32						
R^2	.27						

Note. All moderators were included simultaneously; $\sigma^{2.3}$ = level 3 variance between studies, $\sigma^{2.2}$ = level 2 variance between effect sizes; R^2 = Proportion of explained random variance; k_1 = Number of studies; k_2 = Number of effect sizes; Power = Power to identify a small ($r = .10$) or medium effect ($r = .20$); ^a centered; ^b percentage females; ^c dummy coding; ^d reference group = adults; ^e reference group = self-reported BMI; ^f reference group = continuous measures.



Notes. ^a no results on relevant associations, missing information or associations controlled for third variables. ^b only indicators for screen time, computer use, or video gaming mixed with other media uses (e.g., internet use). ^c focus on active video games, eating behavior, weight loss intervention, health communication. ^d theoretical papers and reviews

Figure 1. Flowchart of the literature search process.

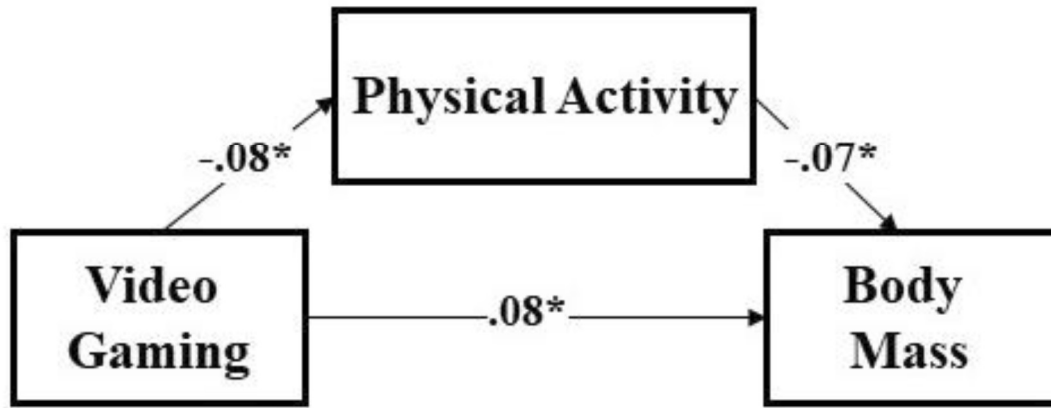


Figure 2. Meta-analytic structural equation model (MASEM). Standardized regression parameters are presented. $*p < .05$

4 Manuscript #3

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Preliminary Note

The third part of this dissertation is the first version of a later published manuscript. In contrast to the published version, the general discussion of this first draft was solely written by myself. The rest of the manuscript was largely written by Markus Appel although all three authors contributed text passages and revisions.

Are Social Media Ruining Our Lives? A Review of Meta-Analytic Evidence

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Abstract

A growing number of studies have examined the psychological corollaries of using Social Networking Sites such as Facebook, Instagram, or Twitter (often called social media). The interdisciplinary research area and conflicting evidence from primary studies complicate the assessment of current scholarly knowledge in this field of high public attention. We review meta-analytic evidence on three hotly debated topics regarding the effects of social media: well-being, academic achievement, and narcissism. Meta-analyses from different labs draw a rather equivocal picture. They show small associations in the $r = .10$ range between the intensity of social media use and loneliness, self-esteem, life satisfaction, or self-reported depression, and somewhat stronger links to a thin body ideal and higher social capital. There is no indication for potential devastating effects of social media on school achievement, social media use and school grades are unrelated for adolescents. The meta-analyses revealed small to moderate associations between narcissism and social media use. In sum, meta-analytic evidence does not support dramatic claims relating social media use to mischief.

Keywords: Social Media; Meta-Analysis; Narcissism; Achievement; Well-Being

Are Social Media Ruining Our Lives? A Review of Meta-Analytic Evidence

The immense popularity of Social Networking Sites such as Facebook, Twitter, Instagram, or Snapchat (often referred to as social media) has fueled a debate on the psychological antecedents, correlates, and consequences of using these platforms. Numerous popular science books, newspaper articles, and blog posts have highlighted the supposedly negative consequences that intense social media use has on individuals and societies as a whole (e.g., Carr, 2010; Lanier, 2018; Turkle, 2011; Twenge, 2017a, 2017b). Others have argued for a more positive view on social media use (e.g., Pinker, 2018). Both perspectives appear to be backed by theory and empirical evidence. There is a large number of diverging empirical findings on social media, thus, commentators can cherry-pick whatever study result fits their scientific, journalistic, or personal narrative. For researchers and educators not deeply involved in the specifics of this research field, evaluating empirical evidence is difficult, if not impossible.

This review goes beyond individual findings. We will clarify the relationships between more or less intensive social media use and key psychological variables by reviewing recent meta-analytic evidence. We focus on three topics of research: well-being, academic achievement, and narcissism. All three areas have attracted a substantial amount of scholarly attention and they are extensively discussed by researchers inside and outside the imminent field, journalists, educators, and parents.

Social Media and the Public Debate

Innovations in the field of communication and technology have been met with criticism since ancient times. Socrates condemned the stylus (a writing utensil made of reed or bone), which enabled people to communicate written language, as he prophesized a downturn of human's memory and cognition (Plato 399-347 BCE / Cooper, 1997). The printing press was met with skepticism (Gessner, 1545, as cited in Blair, 2003), as were

newspapers, because they ostensibly isolated readers from social gatherings. More recently, it was the telephone, the radio, and then the television that were linked to an excess of information, a loss of manners, and a decline of skills and academic performance (e.g., Postman, 1985; see for example Karabell, 2018). Today, social media is among the innovations that are perceived to darken the future of individuals and humankind. As of March 2019, the biggest Social Networking Site Facebook reports 2.38 billion monthly active users (Facebook, 2019) and more than half of US citizens aged 64 or younger use social media regularly (Pew Research Center, 2018).

The popularity of social media and the smartphone has been characterized as a challenge of epic dimensions: Twenge (2017a), for example, states that “the twin rise of the smartphone and social media has caused an earthquake of a magnitude we’ve not seen in a very long time, if ever” and that individuals born since 2000, individuals who grew up with smartphones and social media (sometimes referred to as *iGen*) are doomed: “it’s not an exaggeration to describe *iGen* as being on the brink of the worst mental-health crisis in decades”.¹

Do these and similar worries reflect the status quo of scientific evidence? We review empirical research on the notions that activities on social media a) are related to lower well-being and psychological health, b) are associated with lower performance at school, and c) suit and reinforce narcissism. Unlike other available reviews (e.g., Holland & Tiggemann, 2016; Kuss & Griffiths, 2011; Wilson, Gosling, & Graham, 2012) our focus is on meta-analytic research. Meta-analyses are – as we argue in the following section – a key approach to garner evidence in a field that is contested and rich of conflicting primary studies.

¹ Online source without pagination

The Meta-Analytic Method and Social Media

Research on Facebook, Twitter, and social media in general has surged in recent years. Within five years, academic publications on social media and its psychological correlates have nearly doubled (see Figure 1). Today, more is known on the antecedents and consequences of social media than any time before; but at the same time, the ability to draw generalizable conclusions is limited because few researchers manage to keep track of the steadily increasing research output. Rather, the complexity of the field tempts authors to refer to individual studies that fall in line with their assumptions while ignoring contradictory findings. Borrowing a famous quote, “we find ourselves in the mildly embarrassing position of knowing less than we have proven“ (Glass, 1976, p. 8). Therefore, systematic reviews are indispensable to organize the empirical evidence in a field and summarize the current state of knowledge. Particularly, quantitative reviews in the form of meta-analyses have been advocated to cumulate empirical results on important psychological phenomena (e.g., Braver, Thoemmes, & Rosenthal, 2014; Schmidt & Hunter, 2014).

Meta-analysis refers to a set of statistical methods to aggregate empirical results from individual studies to derive population-level effects between variables (Glass, 1976). Importantly, they allow for the estimation of unbiased effects by correcting for artifacts inherent to most individual studies (Schmidt & Hunter, 2014). Seemingly conflicting findings published in the literature can be frequently attributed to sampling error, measurement error, or other biasing influences that compromise empirical studies (cf. Gnambs, 2014, 2015; Lakens & Etz, 2017; Viswesvaran, Ones, Schmidt, Le, & Oh, 2014). Such conflicting findings are prevalent in research on social media: Some studies, for example, showed that the intensity of using social media was related to more loneliness and less self-esteem (e.g., Lemieux, Lajoie, & Trainor, 2013; Petrocchi, Asnaani, Martinez, Nadkarni, & Hofmann, 2015), whereas others found no such associations (e.g., Jin, 2013; Wohn & LaRose, 2014). Meta-analyses of the available empirical results are able to identify a common effect across

all studies and examine whether the heterogeneity in the observed study results can be attributed to third variables moderating the bivariate relationship or are merely a consequence of unaccounted artifacts. Thus, the meta-analytic method is an essential tool to evaluate the generalizability of psychological phenomena that has been increasingly questioned during the recent replication debate (Open Science Collaboration, 2015). Regarding research on social media, meta-analyses can scrutinize the stability of associations across, for example, different social media platforms, populations, or activities on social media (cf. Ebersole et al., 2016; Klein et al., 2014, 2018; O'Donnell et al., 2018). Moreover, meta-analyses can alleviate the problem of insufficient power in many individual studies (Szucs & Ioannidis, 2017) to identify small effects that are typically encountered in psychological research (Bosco, Aguinis, Singh, Field, & Pierce, 2015; Gignac & Szodorai, 2016).

Despite the potential benefits of meta-analyses, they also leave room for imprecision and subjectivity on part of the researcher (Bangert-Drowns, 1997; Fava, 2002; Lakens, Hilgard, & Staaks, 2016). Although the reproducibility of single meta-analyses has rarely been examined, available evidence suggests that many meta-analytic results in psychology cannot be reproduced in independent replications (Lakens et al., 2017) and methodological errors are common (Gøtzsche, Hróbjartsson, Marić, & Tendal, 2007). Even less is known about the commonality of meta-analytic results conducted with a similar goal by different research labs. Case-wise evidence suggests that different decisions made with respect to the inclusion of studies and statistical procedures can lead to remarkably diverging meta-analytic results. For example, until the emergence of social media, the topic of media violence had dominated scholarly and public discussions on the impact of media use. In this field, meta-analysts have come to diverging results and interpretations with researchers showing clear evidence for a violent media-aggression link (Anderson et al., 2010; Greitemeyer, & Mügge, 2014; see also Boxer, Groves, & Docherty, 2015; Rothstein & Bushman, 2015), whereas

others demonstrate that there is no such substantial link (Ferguson, 2015; Ferguson & Kilburn, 2009; Furuya-Kanamori, & Doi, 2016).

The present review is focused on meta-analyses of correlational studies between social media use on the one hand and narcissism, academic achievement, or well-being on the other hand. These three domains are chosen for two reasons. First, these themes have been extensively discussed by academics and the general public alike. New studies addressing these variables are still published regularly. Second, at least three meta-analyses have been published for each research theme in the past months, allowing us to assess not only the meta-analytic evidence on key themes of social media use, but also on the converging evidence between meta-analytic studies in this research area.

We review the available meta-analytic evidence on the correlates of social media use and evaluate to what degree the pessimistic assertions that have dictated public discussions are supported by empirical evidence. We focus exclusively on cross-sectional, non-experimental research that has dominated research so far and, therefore, has been meta-analytically summarized. Although bivariate correlations do not indicate causality, they are a pre-condition without which a search for causal mechanisms seems futile. Our attempt is falsification: if social media destroyed our lives as suggested by some (e.g., Twenge, 2017a), we would expect moderate to large correlations. Statements on the abysmal influence of social media would suggest large correlations between social media use and psychological indicators of maladjustment. However, large effects are very rare in psychological research (cf. Bosco et al., 2015; Gignac & Szodorai, 2016), so it would be unfair to expect large effects ($r = .50$) in terms of frequently cited benchmarks (Cohen, 1992). Rather, we would reasonably expect effects between $r = .10$ and $r = .30$ that represent typical effects in social psychology according to empirical effect size distributions (Richard, Bond, & Stokes-Zoota, 2003). Thus, we will interpret the available evidence against an association of $r = .20$, reflecting that 4% or

more of variations in well-being (and academic achievement and narcissism) co-vary with social media use.²

Social Media Use and Well-Being

Theoretical Background

Since the advent of social networking sites, researchers have connected digital communication to users' well-being, including their self-concept in terms of self-esteem, life satisfaction, loneliness, and social capital. Several lines of argumentation have been brought up that connect social media use to lower well-being. First, communication on social media might be a replacement of spending valuable time on face-to-face communication (Nie, 2001). There is ample evidence that face-to-face communications with family, friends, and acquaintances is related to higher well-being (cf. Sullivan, 1953; Adams, Santo, & Bukowski, 2011). According to this line of argumentation, communication on social media does not provide the same benefits to well-being as face-to-face encounters, because the former supposedly lacks quality and depth (cf. Yang, Brown, & Braun, 2014). As a consequence, more intense use of social media in terms of time spent online or login frequency should lead to lower well-being. This effect could be amplified by users' negative thoughts and feelings about having wasted time online (Sagioglou & Greitemeyer, 2014).

Second, social media provide ample opportunities for social comparisons (cf. Festinger, 1954). Social media users can compare themselves with other users or celebrities on dimensions that are relevant to self-worth such as attractiveness or social connectedness. Other things equal, individuals tend to engage in upward social comparisons and evaluations tend to be in contrast to the target rather than in line with the target (contrast over assimilation), as corroborated in a recent meta-analysis (Gerber, Wheeler, & Suls, 2018).

² To put this benchmark into perspective: A correlation of .20 corresponds to the effectiveness of nicotine patches on smoking abstinence, is even twice the correlation between gender and risk-taking behavior (Meyer et al., 2001), and compares to the effect of four additional years of education on intelligence gains (Ritchie & Tucker-Drob, 2018).

Thus, the intensity of using social media should be associated with more detrimental social comparisons, which in turn should be related to lower well-being. The tendency of online community members to select and create highly flattering portrays of themselves should contribute to negative social comparisons outcomes (Feinstein et al., 2013; Fox & Vendemia, 2016).

Third, intense social media use increases the likelihood of being exposed to and engaging in highly self-worth endangering online communication, such as cyberbullying, grooming by strangers, and sexting. Being the victim (as well as the perpetrator) of cyberbullying has been connected to lower well-being (for meta-analytic evidence see Kowalski, Giumetti, Schroeder, & Lattanner, 2014). Finally, the more individuals are ‘permanently online – permanently connected’ on social media (Vorderer, Hefner, Reinecke, & Klimmt, 2017), the higher the mental load due to multitasking, the higher their stress, and the worse the quality and quantity of sleep, all factors associated with lower well-being.

Other lines of argumentation have related social media use to a potential for higher well-being. First, social contacts via social media could be valuable by providing and psychologically representing social capital (Ellison, Steinfield, & Lampe, 2007; Wang, Chua, & Stefanone, 2015), that is, “the aggregate of the actual or potential resources which are linked to possession of a durable network of more or less institutionalized relationships of mutual acquaintance and recognition” (Bourdieu, 1985, p. 51). More social capital, in turn, is associated with higher well-being. Second, the feedback obtained via social media is often positive (there is no dislike button on Facebook) and positive feedback is related to higher well-being (Burrow & Rainone, 2017). Third, social media provide ample access to information and communication partners, they offer extra means and time to create one’s own messages, and the level of anonymity can be adjusted. As compared to face-to-face communication, these additional opportunities increase people’s degrees of freedom and the

controllability of social encounters. Therefore, social media can assist users' self-presentation and self-disclosure (cf. Valkenburg & Peter, 2011). Successful self-presentation and self-disclosure, in turn, are associated with higher well-being (Kim & Lee, 2011).

Meta-Analytic Evidence

Four meta-analyses have recently addressed the relationship between social media use and indicators of well-being (Huang, 2017; Liu, Ainsworth, & Baumeister, 2016; Liu & Baumeister, 2016; Mingoia, Hutchinson, Wilson, & Gleaves, 2017). This includes meta-analytic analyses on self-esteem, life satisfaction, depression, and loneliness. Moreover, meta-analytic findings on social capital and the internalization of a thin body ideal are reported, as these variables represent relevant mechanisms assumed to reflect the association between social media and well-being (Table 1). Note that one additional meta-analysis on loneliness was not included in this review because the validity of this meta-analysis is questionable (Song et al., 2014).³

Main findings are summarized in Figure 2 and Table 1. The associations between the time spent with social media or a global measure of social media usage intensity on the one hand and the well-being indicators on the other hand were significantly ($p < .05$) negative, as indicated by findings on self-esteem (Huang, 2017: $r = -.04$, 95% CI[-.08; -.00]; Liu & Baumeister, 2016: $r = -.09$, 95% CrI[-.14; -.03]⁴), life satisfaction (Huang, 2017: $r = -.03$, 95% CI[-.11; -.01]), and depression (Huang, 2017: $r = .11$, 95% CI[.07; .15]). However, the identified pooled effects were rather small: Social media use explained about 1% of variance in the well-being indicators at the most. These results provide only weak support for the assumption that the intensity of social media use is associated with lower self-esteem, less life

³ In their meta-analysis on social media and loneliness Song and colleagues (2014) also included primary studies that investigated the link between social media and extraversion/introversion, because introversion was perceived to be a measure for loneliness. We believe that introversion and loneliness are too different to conceive one as a measure of the other (see, for example, Mund & Neyer, 2016).

⁴ The authors did not report standard errors or confidence intervals but provided the credibility interval (CrI).

satisfaction, and more depression. Regarding loneliness, the associations were quite similar to the other well-being indicators (Huang, 2017: $r = .08$, 95% CI[.04; .13]; Liu & Baumeister, 2016: $r = .17$, 95% CrI[-.09; -.24]) and also failed to substantiate a large association. When different patterns of social media behaviors were analyzed, the size of one's social network (i.e., the number of followers or friends) was positively associated with self-esteem; however, the respective effects were small, $r = .07$, 95% CrI[.01; .14] (Liu & Baumeister, 2016). Generally stronger support was obtained for the relationship between social media use and the internalization of a thin body ideal, $r = .18$, 95% CI[.12, .23] (Mingoia et al., 2017), and for the relationship between social media use and social capital (Liu et al., 2016): Social media use indicators were associated with the creation and maintenance of superficial interpersonal relationships (without strong emotional involvement) at $r = .32$, 95% CI[.27, .37] and, to a lesser degree, also with the maintenance of close, intimate relationships at $r = .22$, 95% CI[.21, .24]. Thus, meta-analytical evidence provides some support for both, social comparison processes (linked to lower well-being) as well as for higher social capital (linked to higher well-being).

Some meta-analyses observed substantial heterogeneity between the pooled studies indicating unaccounted moderating influences. For example, the 95% credibility interval for social media effects on self-esteem (Liu & Baumeister, 2016) ranged from $r = -.14$ to $-.03$. With respect to moderation analyses, Liu and Baumeister (2016) found some indication of cultural differences: The relationships between general social media use or social media interactions on the one hand and self-esteem on the other hand were smaller in studies with Western samples (North America and Europe) as compared to studies with Asian samples (e.g., China or Korea). Moreover, social media use and bridging social capital (i.e., regarding superficial, weak ties) were more strongly related in Western cultures; no influence of culture was observed for bonding social capital (Liu et al., 2016). Regarding moderation effects of gender, findings were mixed. Whereas Huang (2017) and Liu and Baumeister (2016)

identified no effect of gender (i.e., the proportion of female participants in the primary studies), the relationship between social media use and social capital decreased with an increasing proportion of women, indicating the link between social media use and bridging social capital could be more pronounced for men than for women (Liu et al., 2016).

Conclusion

The available meta-analyses provide only weak support for a negative linear association between well-being and social media use. Our benchmark of $r = .20$ (4% shared variance) – indicating a noteworthy support for potential devastating effects of social media – was not met in the relationships between social media use and life satisfaction, depression, or related indicators of well-being. Despite claims made by journalists or authors of popular science books, meta-analytic summaries show no strong linear link between the overall intensity of social media use and loneliness, self-esteem, life satisfaction, or self-reported depression. More proximate potential correlates of social media use (intensity of the thin body ideal; social capital) yielded higher effect sizes, exceeding our benchmark of effect sizes greater than .20. Particularly, the association with social capital suggested some positive effects of social media use. Social media seem to provide a platform for the creation and maintenance of close and intimate (but also more shallow) relationships (Liu et al., 2016). However, given the rather small correlation between the number of friends or followers on social media and self-esteem (Liu & Baumeister, 2016), it is questionable whether increases in social capital with the help of social media can translate into meaningful well-being gains. Overall, the available meta-analytic evidence casts doubt on the assumption of substantial associations between social media use and well-being.

Social Media Use and Academic Achievement

Theoretical Background

Given the popularity of social media among students, the relationship between social

media use and academic success has become a major topic of debate. Social media use is reported to be a risk factor for academic underperformance (Kirschner & Karpinski, 2010). Several processes may account for a negative link between social media use and academic performance. A time displacement rationale suggests that the time spent with social media reduces the time spent for learning and preparation (Nie, 2001; see Tokunaga, 2016). Other things equal, less study time would in turn contribute to poorer academic performance (Stinebrickner & Stinebrickner, 2004). Relatedly, the time spent with social media could also reduce the quality and quantity of sleep (Orzech, Grandner, Roane, & Carskadon, 2016; Xanidis & Brignell, 2016) and healthy sleep is beneficial for academic achievement (Dewald, Meijer, Oort, Kerkhof, & Bögels, 2010). As a further challenge, social media can be used during times of instruction and learning. This social media multitasking likely reduces the working memory capacity available for the concurrent scholastic activities and could therefore lead to a negative association between social media use and academic achievement (van der Schuur, Baumgartner, Sumter, & Valkenburg, 2015; Wood et al., 2012).

From a different perspective, however, social media use could contribute to better academic achievement. Social media can be used as a means to communicate school-related information. Social media can facilitate student-to-student discussions of learning matter, establish course groups, or enable student-teacher interactions (e.g., Junco, Heiberger, & Loken, 2011; Lampe, Wohn, Vitak, Ellison, & Wash, 2011). As outlined earlier, social media could further help at developing social capital (Ellison et al., 2007, 2011; Wang et al., 2015). Social capital in turn is an important resource for students' academic achievement (Eckles & Stradley, 2012; Yu et al., 2010).

Meta-Analytic Evidence

Three meta-analytic summaries were recently published on this topic of social media and academic achievement (Huang, 2018; Liu, Kirschner, & Karpinski, 2017; Marker,

Gnambs, & Appel, 2018). As illustrated in Table 2, all three meta-analyses reported significant associations between school grades and general measures of social media use, time spent, frequency of logins, and other measures of social media use intensity. The reported findings were highly consistent across these meta-analyses with associations ranging from $r = -.09$ to $r = -.07$. The respective pooled effects were rather small, with the social media indicators explaining less than 1% of variance in school achievement. Importantly, the negative association was only found for studies that used self-reported achievement measures, $r = -.09$, 95% CI[-.15, -.03], whereas objective achievement (e.g., grade point averages retrieved from official school records) was not related to social media use, $r = .01$, 95% CI[-.02, .04] (Marker et al., 2018). These results provide no to rather weak support for the assumption that the intensity of social media use contributes to underperformance in school.

Marker and colleagues (2018) also highlighted different associations between two specific types of social media use and academic achievement: The association between measures of multitasking social media use and achievement yielded an average association of $r = -.10$, 95% CI[-.16, -.05], whereas social media used for academic purposes resulted in a significant association in the opposite direction, $r = .08$, 95% CI[.02, .14]. Finally, the authors also provided a meta-analytic test of the time displacement hypothesis (Nie, 2001; see Tokunaga, 2016) that is presumably responsible for the negative association between social media activities and school achievement. Social media use was found to be unrelated to study time, $r = -.03$, 95% CI[-.11, .06], therefore, providing no support for a time displacement rationale in a related meta-analytical structural equation model (MASEM; Cheung, 2015).

Moderator analyses for the three meta-analyses identified some consistent influences of third variables. For example, time spent with social media was more strongly related to academic achievement, $r = -.10$, 95% CI[-.13, -.06] as compared to frequency of social media use, $r = -.01$, 95% CI[-.07, .05] (Huang, 2018); similar results were also reported by Liu et al.

(2017), albeit based on only two to three effects. Negative associations between social media use and academic achievement seem to be slightly larger for older respondents such as college students, $r = -.09$, 95% CI[-.16, -.01] (Liu et al., 2017), or undergraduates and adults, $r = -.08$, 95% CI[-.14, -.02] (Marker et al., 2018) as compared to middle and high school students, $r = .01$, 95% CI[-.09, .12] (Liu et al., 2017) or adolescents $r = .01$, 95% CI[-.05, .06] (Marker et al., 2018). In contrast, Huang (2018) identified no age-related differences. Regarding gender differences, no consistent results were reported. Although Liu and colleagues (2017) identified a stronger negative association in samples with a larger percentage of women, Huang (2018) failed to corroborate this effect. Cross-cultural differences were only addressed in Marker et al. (2018), but revealed no unique pattern.

Conclusion

All three meta-analyses identified average associations below $r = -.10$. Based on the current evidence, the relationship between social media use and academic achievement is far lower than our benchmark of $|r = .20|$. Thus, there is no indication for potential devastating effects of social media on school achievement, even if self-reported multi-tasking social media use is examined. Remarkably, two meta-analyses obtained no relationship at all between social media use and grades among the subgroup of younger, adolescent participants.

Social Media Use and Narcissism

Theoretical Background

Scholars have observed a severe increase in average narcissism personality scores in the last decades (“generation me”, e.g., Twenge, 2014; Twenge, Konrath, Foster, Campbell, & Bushman, 2008; for opposing positions see for example Trzesniewski & Donnellan, 2010).

Against this background, it has been argued that narcissistic tendencies can be expressed and nourished by engaging with social media, leading to even more narcissism on the societal level (Twenge, 2013).

There are several features of communication via social media that differ from offline communication (Valkenburg & Peter, 2011), features that might be particularly appealing for individuals high on narcissism (Gnambs & Appel, 2018). First, social media enable individuals to communicate self-related information to a large number of friends, acquaintances, and strangers, and others can give feedback to an individual's social media activities. Narcissists are highly motivated to reach a large number of communication partners in order to receive constant validation of their embellished self-views, hence, social media should be sought after platforms. Second, users of social media can choose which information to communicate and which information to keep to themselves. Parts of the self that do not fit a narcissist's self-concept can be more easily hidden than in face-to-face interactions. Third, social media allow to meticulously choreograph one's online appearance.

Communication is asynchronous and verbal and visual messages can be selected and improved prior to posting. Moreover, the intense self-focus initiated by many social media activities could promote users' narcissism (Gentile, Twenge, Freeman, & Campbell, 2012).

Meta-Analytic Evidence

In recent years, three meta-analyses on the link between narcissism and social media have been published (Gnambs & Appel, 2018; Liu & Baumeister, 2016; McCain & Campbell, 2018). These meta-analyses were based on primary studies that had connected self-reported narcissism to self-reported usage intensity and activities on social media. The majority of primary studies and meta-analytic results related to grandiose narcissism (characterized by a sense of self-importance, grandiosity, and dominant behavior), much fewer research was devoted to vulnerable narcissism (characterized by interpersonal hypersensitivity and social withdrawal; cf. Miller et al., 2011). The main meta-analytic results are represented in Table 3.

Grandiose narcissism and global measures of social media use, such as the time spent or usage intensity, were positively related with associations ranging from $r = .11$, 95% CI [.04,

.18]) in the meta-analysis by McCain and Campbell (2018) to $r = .17$, 95% CI[.04, .33] in the meta-analysis by Gnambs and Appel (2018). In all three meta-analyses, usage behavior that reflects active self-presentation yielded associations with narcissism in the range of $r = .14$, 95% CI[.06, .21] for posting selfies (McCain & Campbell, 2018) to $r = .26$, 95% CI[.18; .33] for posting photos (Liu & Baumeister, 2016). A relatively large average correlation was reported for social media interactions (i.e., posting comments or providing 'likes'), $r = .42$, 95% CI[.17; .62] in Liu and Baumeister (2016), however, based upon six effects only. Number of friends and narcissism were consistently associated with coefficients ranging between $r = .18$, 95% CI[.05; .30] and $r = .20$, 95% CI[.09; .31] in all three studies.

Meaningful moderation effects were observed for the country or culture the primary studies were conducted in. Liu and Baumeister (2016) reported a tendency indicating that relationships between narcissism and social media use were stronger in Asian and collectivistic cultures than in the Western and individualistic cultures. Based on Hofstede's cultural dimensions, Gnambs and Appel (2018) observed a linear increase of the focal effect size with the countries' power distance: Countries with larger power distance (such as Malaysia or India) exhibited larger associations between narcissism and social media behavior than countries with smaller power distance (such as Austria or the Netherlands). Other sample characteristics such as the age or gender distribution exhibited no moderating influences (Gnambs & Appel, 2018; Liu & Baumeister, 2016).

Conclusion

Meta-analytic evidence is in support of small to moderate associations between narcissism and social media use. We do find associations that exceed the threshold effect size of $r = .20$ (4% shared variance) – indicating that grandiose narcissism is substantially linked to social media activities. Narcissists tend to have more social media friends and it appears that popular activities that enable self-promotion are particularly strongly associated with

narcissism. Moreover, these relationships appear to be larger in non-Western than in Western countries.

General Discussion

The intricate connection between the world online and the world offline is arguably one of the most astonishing and challenging developments that the social sciences of today are faced with. Journalistic features and popular books alert their readers despite scientific evidence not being conclusive. This review summarized meta-analytic evidence on correlates of social media use. More precisely, it answered the questions on relationships between social media use and well-being, academic achievement as well as narcissism.

When two or more meta-analyses investigate the same question, their results should be similar. Indeed, the meta-analyses with the same research questions yielded equivalent results, which speaks for the robustness of their findings. To interpret the relationships, we decided to determine a threshold of $r = .20$ to indicate a substantial association. Overall, the reviewed meta-analyses reported rather small relationships below this threshold for nearly all variables. For well-being and academic achievement, the effects were below this threshold and, therefore, small to negligible. Thus, social media use is not closely related to individual well-being or academic achievement. For narcissism, the link to social media use exceeded the threshold and was consequently interpreted as substantial. Higher social media use was more common for individuals high in narcissism. Overall, the effect sizes of the relationships between social media use and psychological variables were modest and shared less than 4% of the variances. In contrast to the fears of parents and teachers, the results showed no stronger effects for younger participants. When age differences were reported, the opposite was true: Children and adolescents were unaffected and showed fewer negative associations between social media use and psychological variables. This might indicate an adaption to the digital environment younger people grow up in (Mills, 2016), although this view is rejected in

the current literature on digital natives (e.g., Kirschner & De Bruyckere, 2017; Šorgo, Bartol, Dolničar, & Boh Podgorni, 2017). There were some cultural differences, especially with regard to non-Western versus Western cultures.

The reported meta-analytic relationships were small to moderate, but causal interpretations cannot be drawn from these correlations. Although the correlation between narcissism and social media use was substantial, it does not support the assumption of a negative influence of social media on narcissism. Whether the use of social media produces a more narcissistic generation or if narcissistic individuals use social media more often cannot be answered at this point. The current meta-analyses reported correlational results, conclusions on the effect directions are still to be drawn.

The assumed relationships underlying the reviewed meta-analyses were linear. Higher social media use would be correlated with higher (or lower) scores on the psychological variables. However, nonlinear relationships seem plausible too. A reasonable amount of social media use can be beneficial for well-being while too much time spent with social media would correlate in the opposite direction (Przybylski, & Weinstein, 2017). In cases of excessive or addictive social media use negative associations with health variables are likely (e.g., Andreassen, Pallesen, & Griffiths, 2017; Hawi & Samaha, 2017). On the other hand, not using social media might lead to feelings of exclusion (e.g., TheCyberPsyche, 2013) or even disadvantages in a person's social or professional life (e.g., when invitations for social events are spread only via Facebook or companies recruit for jobs via LinkedIn).

The Method of Meta-Analysis

Synthesizing evidence to create a coherent picture of the state of research is still challenging within the framework of a narrative review. Instead a review of meta-analytic evidence provides an overview of quantified summaries that reported on similar topics. In cases of unclear research questions, such an overview can then support a conclusion on a

more general (or meta-) level, for example negative consequences of social media use. Meta-analyses are not without limitations, but so far the best approach available to summarize evidence. With meta-analytic evidence on complex issues, it is less appealing for people (journalists as well as scientists) to cherry-pick studies that support a certain narrative (e.g., common fears on social media use). Moreover, many media theories in psychology are typically more complex than simple bivariate effects. For example, new media effects on academic achievement have been attributed to various displacement effects (Gnambs, Stasielowicz, Wolter, & Appel, 2018): The time spent with media devices displaced time needed for homework and learning activities and, in turn, impaired school outcomes. Recent methodological developments now also allow addressing these questions in a meta-analytic framework (Cheung, 2015; Cheung & Hong, 2017). One can create a meta-analytic correlation matrix among variables that do not have to be measured in the same study. Structural equation modeling applied to these meta-analyzed correlations can be used to test complex multivariate hypotheses such as the mediating effect implied by the time displacement hypothesis (see Marker et al., 2018). Thus, meta-analyses can contribute to theory building and evaluation in media research.

Meta-analyses might profoundly shape the future direction of research by quantifying the current knowledge (e.g., regarding the size and robustness of an effect): Rather than investing more time and money in replicating an effect that is meta-analytically well-established, future efforts should be spent towards refining an effect (e.g., identifying moderating influences) or generalizing it to adjacent fields. For public debates, meta-analyses help to falsify perceived truism on media dangers and to prevent the spread of unnecessary fears. The problem with media effects lies in their complexity. Media effects usually occur due to an interplay of the media, but also personality and context variables (e.g., violent video gaming may have more substantial effects on aggressiveness for people low in agreeableness and living in a context of violent homes). However, simple and short answers (e.g., violent

video gaming leads to more aggression) are easier to remember. Moreover, people tend to believe that others are more influenced (by the media) than themselves (i.e., third person effect; Davison, 1983; Perloff, 1993), which could foster discussions about prohibitions. Some narratives might suit certain political views and are therefore more present in the media. Hence, meta-analyses are necessary to summarize empirical evidence to communicate it comprehensibly and support a reasonable evaluation of possible media effects.

Conclusion

In summary, the pessimistic assertions in general discussions about social media use were not supported by meta-analytic evidence. Social media do not destroy our lives. As they are a part of everyday life, they naturally interact with other aspects of their users' lives. Against some expectations, these associations do not have to be exclusively negative (e.g., the development of social capital). We therefore call for a more moderate dealing with negative claims in public discussions and media reports, and conclude that for the case of social media, empirical research does not support substantial negative effects. Furthermore, our review emphasizes the advantages of meta-analytic summaries on media psychological questions. We believe that meta-analyses can reduce the complexity of research results and facilitate the assessment of the magnitude of media effects.

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Table 1. Meta-analytic results on the association between patterns of social media use and well-being indicators

Publication	Social media indicator	Psychological variable	No of effect sizes	No of participants	Effect size r or ρ 95% CI [LL; UL]
Huang, 2017	Time spent on social media	Well-being total ^a	67	19,965	-.07 [-.09; -.04]
	Time spent on social media	Loneliness	20		-.08 [-.13; -.04]
	Time spent on social media	Self-esteem	30		-.04 [-.08; -.00]
	Time spent on social media	Life satisfaction	8		-.03 [-.11; -.01]
	Time spent on social media	Depression	24		-.11 [-.15; -.07]
Liu & Baumeister, 2016a ^b	All available indicators	Loneliness	23	7,397	.17 [.09; .24]
	All available indicators	Self-esteem	33	10,627	-.09 [-.14; -.03]
	No of friends	Self-esteem	11	3,035	.07 [.01; .14]
	Interaction	Self-esteem	3	969	.11 [-.10; .31]
	Photos	Self-esteem	8	1,964	-.01 [-.13; .10]
	Status	Self-esteem	4	685	-.02 [-.10; .07]
Mingoia et al., 2017	Global social media use (time per day)	Internalization of a thin body ideal	6	1,829	.18 [.12; .23]
	Appearance-related social media use	Internalization of a thin body ideal	6	539	.21 [.15; .28]

Liu et al., 2016	Global social media use (frequency, intensity, time)	Bridging social capital	50	22,290	.21 [.27; .37]
	Self-disclosure	Bridging social capital	9	3,793	.19 [.27; .37]
	Entertainment/fun	Bridging social capital	4	1,651	.17 [.27; .37]
	Offline friends	Bridging social capital	6	1,937	.23 [.27; .37]
	Information seeking	Bridging social capital	13	4,532	.25 [.27; .37]
	Replying and maintaining	Bridging social capital	11	5,221	.36 [.27; .37]
	Online friendship initiation	Bridging social capital	2	1,055	.09 [.27; .37]
	Global social media use (frequency, intensity, time)	Bonding social capital	43	19,439	.22 [.21; .24]
	Self-disclosure	Bonding social capital	7	2,768	.20 [.16; .24]
	Entertainment/fun	Bonding social capital	4	1,651	.12 [.07; .17]
	Offline friends	Bonding social capital	5	1,817	.25 [.21; .30]
	Information seeking	Bonding social capital	9	2,765	.18 [.14; .21]
	Replying and maintaining	Bonding social capital	9	4,418	.24 [.21; .27]
	Online friendship initiation	Bonding social capital	2	1,055	.03 [-.03; .09]

Notes: ^aAn aggregate of loneliness, self-esteem, life satisfaction, and depression.

^b Credibility Intervals were reported

Table 2. Meta-analytic results on the association between patterns of social media use and academic performance

Publication	Social media indicator	Psychological variable	No of effect sizes	No of participants	Effect size r or ρ 95% CI [LL; UL]
Huang, 2018	General social media use (Time spent and frequency pooled)	School grades (two studies on writing included)	40	21,367	-.09 (-.07 without outlier)
	Time spent	School grades	28	NA	-.10
	Log-in frequency	School grades	12	NA	-.01
Liu et al., 2017	General social media use ^b	School grades (2 studies on literacy included)	28	101,847	-.08 [-.13; -.02] ^a
Marker et al., 2018	General social media use ^b	School grades total	55	25,432	-.07 [-.12; -.02]
	General social media use ^b	School grades student-reported	41	NA	-.09 [-.18; -.01]
	General social media use ^b	School grades documented	14	NA	-.01 [-.20; .19]
	General social media use ^b	Time spent studying	10	3130	-.03 [-.11; .06]
	Multitasking social media use	School grades	15	7,615	-.10 [-.16; -.05]
	Social media use for academic purposes	School grades	10	2,589	.08 [.02; .14]

Notes. ^aAlthough the upper bound is specified as .02 (without the negative sign) in the text, we infer from the text that this is a typo. ^bTime spent, frequency, or intensity of use.

^cAlthough the upper bound was specified as -.059 in Table 2 (with a negative sign), we infer from the text that the negative sign is a typo.

Table 3. Meta-analytic results on the association between patterns of social media use and narcissism

Publication	Social media indicator	Psychological variable	No of effect sizes	No of participants	Effect size r or ρ 95% CI [LL; UL]
Gnambs & Appel, 2018	All available indicators	Narcissism all indicators	289	25,631	.17 [.13; .20]
	All available indications	Grandiose Narcissism	266	25,168	.17 [.13; .21]
	All available indications	Vulnerable Narcissism	14	602	.08 [-.07; .24]
	Usage duration	Grandiose Narcissism	28	7,233	.14 [.06; .22]
	Usage frequency	Grandiose Narcissism	29	3,715	.16 [.02; .31]
	Usage intensity	Grandiose Narcissism	14	2,614	.18 [.04; .33]
	No of friends	Grandiose Narcissism	43	14,481	.20 [.09; .31]
	Written self-presentation	Grandiose Narcissism	70	11,922	.15 [.10; .20]
	Visual self-presentation	Grandiose Narcissism	23	5,478	.23 [.14; .33]
	Group memberships	Grandiose Narcissism	5	1,319	.07 [-.05; .20]
Liu & Baumeister, 2016	Global use indicators together	Narcissism	19	7,271	.13 [.06; .20]
	No of friends	Narcissism	10	3,398	.18 [.05; .30]
	Interaction	Narcissism	6	1,457	.42 [.17; .62]
	Photos	Narcissism	17	5,048	.26 [.18; .33]
	Status	Narcissism	9	3,700	.14 [.03; .25]
McCain & Campbe II, 2018	Time spent on social media	Grandiose Narcissism	18	6,132	.11 [.04; .18]

No of friends	Grandiose	24	10,079	.20 [.14; .26]
	Narcissism			
Selfies	Grandiose	8	3,853	.14 [.06; .21]
	Narcissism			
Status Updates	Grandiose	21	7,371	.18 [.11; .26]
	Narcissism			
No of friends	Vulnerable	4	1,033	.21 [-.06; .49]
	Narcissism			
Selfies	Vulnerable	3	967	.05 [-.02; .11]
	Narcissism			
Status Updates	Vulnerable	3	575	.42 [-.01; .85]
	Narcissism			

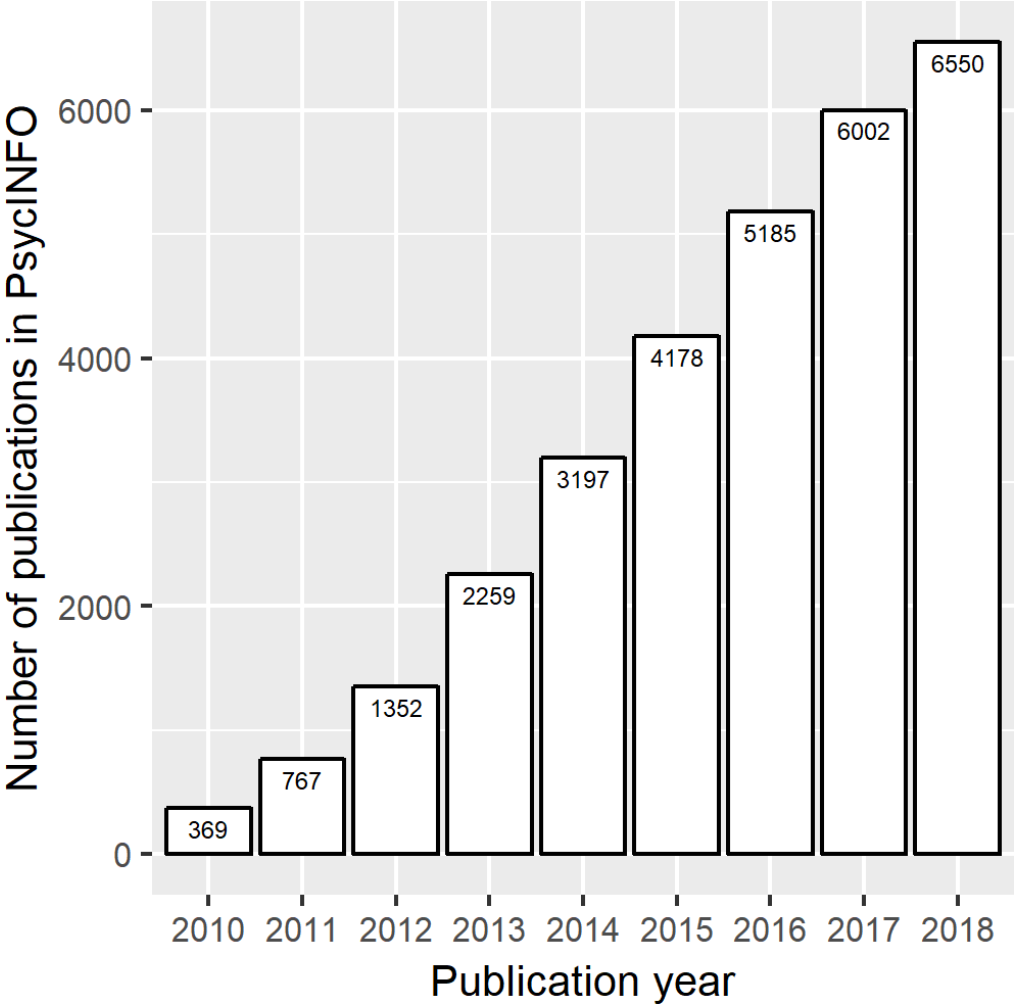


Figure 1. Number of publications indexed in PsycINFO for the keyword “online social networks” between 2010 and 2018.

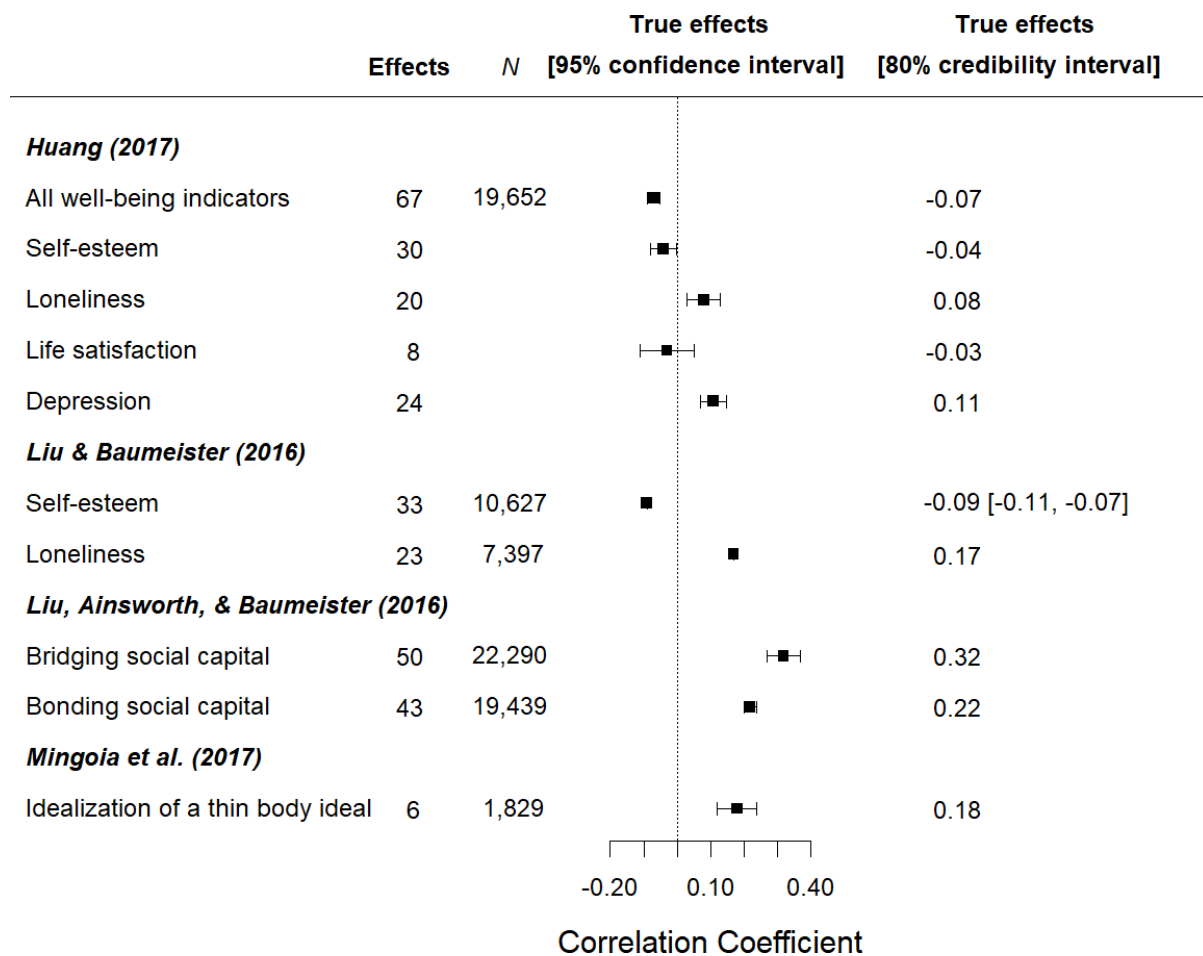


Figure 2. Meta-analytic associations between general indicators of social media use and measures of well-being. Huang (2017) included only time spent on social media as indicator. Missing information for sample sizes or credibility intervals was not reported in the meta-analyses.

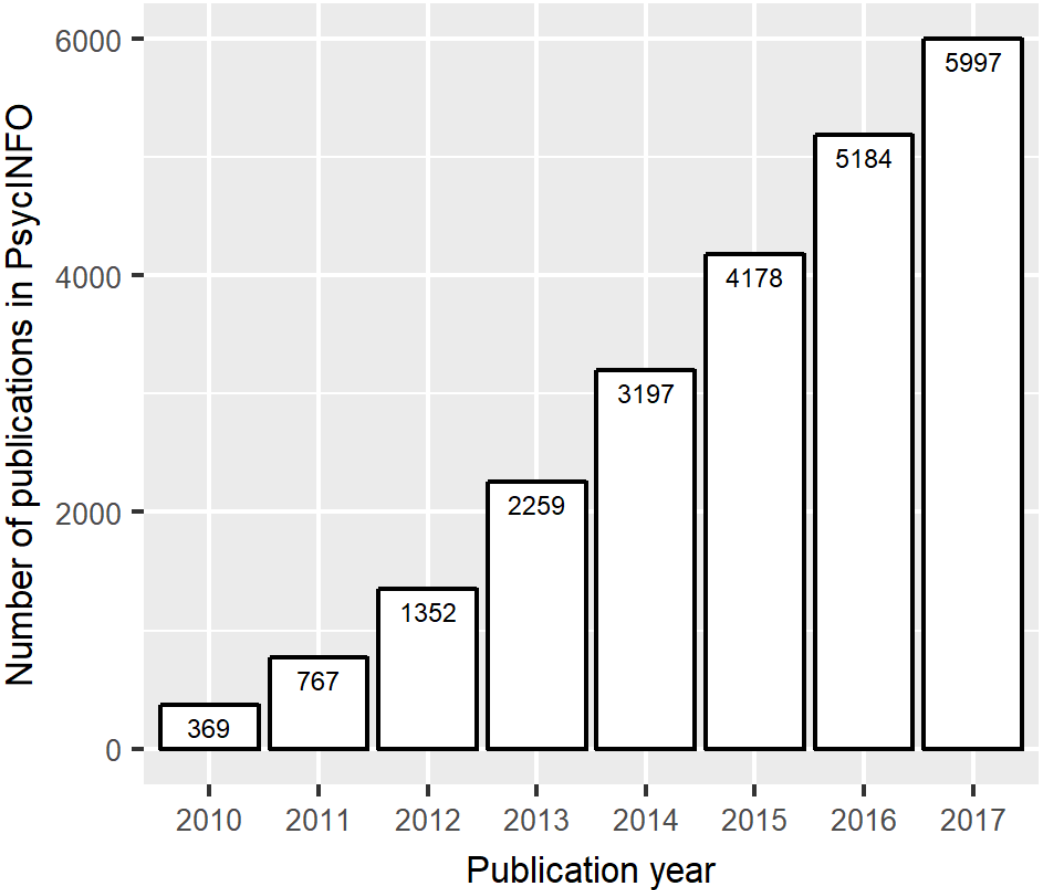


Figure 1. Number of publications on social media indexed in PsycINFO by publication year.

5 Final Discussion

The rise of digital technologies has been seen as a curse and a blessing. Although new technologies are designed to simplify everyday life, they are often criticized. The topic of this dissertation was to analyze the negative effect that media use is often expected to have. This highly discussed topic was the focus of the research questions, which were approached through the method of meta-analysis. This method, which involves summarizing single studies, allowed a more conclusive answer on specific media effects. Manuscript #1 revealed small associations between social media use and academic achievement. The effect directions of these relationships were negative when people used them for general and multitasking purposes, but positive when social media were used for academic purposes. The negative association with general SNS use was not mediated by study time. Manuscript #2 found a small positive relationship between video gaming and body mass as well as indications that physical activity was replaced by video gaming. Manuscript #3 summarized meta-analytic evidence on social media correlates. Overall, the reported effect sizes were small to moderate. Four meta-analyses revealed a small negative relationship between social media and well-being. Three meta-analyses reported a negative correlation between social media use and academic achievement. Moreover, three meta-analyses found social media and narcissism to be positively related. Manuscripts #1 and #2 successfully contributed to meta-analytic evidence in media psychology literature. Manuscript #3 summarized the meta-analytic evidence on an overarching question concerning social media correlates. All three manuscripts enhance our understanding of digital media effects and provide findings in exactly the areas where knowledge gaps still remain.

The following chapter (5.1) describes the implications for the media effects investigated in the manuscripts. The existence and the amount of possible dangers will be reviewed. The moderating variables and factors that could not be investigated will be discussed. The limitations of the manuscripts will be explored and an outlook for further

research will be given. Chapter 5.2 will evaluate the implications of using meta-analyses in the field of media psychology. Both the benefits and the limitations of the method will be discussed, and the learnings from the manuscripts will be related to the findings of existing literature on meta-analytic methods. Furthermore, Chapter 5.3 will discuss what should follow these findings: their dissemination into public debate. Meta-analyses will be reviewed in the light of their possible contribution to science communication. An outlook with open questions for further research will be included. Finally, the findings of this dissertation will be summarized with a return to the bigger picture.

5.1 Media threats – Implications of the meta-analytic evidence

5.1.1 Implications of the three manuscripts

Many threats are expected to arise from new media formats. A central fear of parents and scholars is the negative influence social media might have on students' academic achievement. Good grades are necessary for children's subsequent professional existence. Their individual success and wellbeing depend on their achievements in earlier days. Moreover, the whole society profits from a well-educated young generation that provides a bright future. Therefore, a possible negative impact of social media would be a relevant factor for the whole generation of millennials. Manuscript #1 investigated the heterogeneous study base on the relationship between SNS and academic achievement. Small negative relationships were found when individuals used SNS generally (e.g., time spent with SNS) and for multitasking. The higher an individual's use of SNS (in general and while multitasking), the poorer were his or her grades. However, this relationship only remained stable in studies based on self-reported achievement measures. When grades were obtained from schools, the negative association with general SNS use vanished (moderator analyses were only conducted on general SNS use because of the sample size of studies). This reveals the importance of the measures used in empirical studies. Although self-reported grades were found to be consistent with real grades (Shaw & Mattern, 2009), the meta-analytic moderator

analysis showed significant differences between studies using self-reported versus objective grades.

A second important finding concerned the usage pattern. When SNS were used for academic purposes (e.g., organizing learning groups), a reverse effect was found. The more an individual used SNS for academic purposes, the better were his or her grades. This shows the importance of differentiating between usage patterns. Generalizations regarding social media (or even all new media) are not appropriate and do not reflect empirical evidence. Moreover, the effect sizes found in Manuscript #1 were small. Study time, for example, was a stronger predictor of academic success (see Manuscript #1). The results also did not confirm a possible displacement of study time through SNS time. This refutes the assumption that students perform poorly because they spend time with SNS instead of studying.

From a methodological perspective, following the approach of Peterson and Brown (2005), we included corrected beta-weights in the first meta-analysis. Although such an inclusion is controversially discussed (e.g., Ferguson, 2015; Rothstein & Bushman, 2015), we decided to include beta-weights to reduce information loss. However, we also conducted a sensitivity analysis to differentiate between zero-order and second-order effect sizes. The results showed significant differences, indicating a significant negative relationship for zero-order effect sizes but not for second-order effect sizes. This systematic difference confirmed our assumption that second-order effect sizes differ considerably from zero-order values. Because the source of these differences cannot be isolated (every beta-weight resulted from different covariates), we recommend removing second-order effect sizes from meta-analyses, in line with other authors (Rothstein & Bushman, 2015).

In summary, Manuscript #1 extended existing knowledge on the relationship between social media use and academic achievement. Besides the findings on different usage patterns, it disproved the hypothesis that study time is displaced by time spent in social media. The

manuscript further underscored the differences between achievement measures, which should be kept in mind for future studies, as well as the differences between zero- and second-order effect sizes in meta-analytic summaries.

In the context of the possible negative impact of new media use, another commonly used entertainment medium is discussed: video gaming. Half of America's adults play video games (Duggan, 2015). Video gaming has received a lot of rather negative attention in the last decades, mostly it is assumed to result in aggression and violent behavior. But this is only one variable associated with video gaming. Another widely spread stereotype is related to the physical health of gamers. Usually gamers play video games sitting down. The image has emerged of an obese gamer sitting in front of a screen consuming sweet soft drinks and unhealthy food. Overweight and obesity are relevant health concerns, not only because they are correlated with a lot of diseases (e.g., diabetes, heart or joint diseases), but also because they affect an individual's ability to participate in social activities and influence his or her psychological wellbeing, self-esteem, and even job chances (e.g., Daly, Robinson, & Sutin, 2017; Finkelstein, Demuth, & Sweeney, 2007; Harrist et al., 2016). Manuscript #2 investigated the myth of the obese gamer. The rising overweight and obesity rates call for a better understanding of their causes, and the public often associates them with sedentary media use such as television and video gaming (e.g., Ghalabi, 2013; Stibich, 2018). While empirical literature has clearly established an association with television viewing (e.g., Ghobadi et al., 2018; Mistry & Puthussery, 2015), studies on video gaming and overweight have yielded heterogeneous findings (e.g., Bickham, Blood, Walls, Shrier, & Rich, 2013; Siervo, Cameron, Wells, & Lara, 2014). Our meta-analytic summary found a small positive association between overweight and gaming, indicating that more time spent playing video games is associated with higher body mass. This relationship was more pronounced for adults than for children and adolescents, with body mass significantly connected to video gaming only in adults. The overall effect size, however, was small, explaining less than 1% of the

variance in body mass. Manuscript #2 therefore does not support a strong link between the two variables. Other factors such as dietary behavior or physical activity are probably stronger predictors of body mass (Stubbs & Lee, 2004; Van Dyck et al., 2015). Thus the meta-analysis revealed slight indications that physical activity was replaced by video gaming, using a meta-analytic structural equation model. This effect was based on a small subsample of studies, pointing toward a potential area for future research.

In conclusion, Manuscript #2 extended the literature on video gaming and body mass. Again, moderator analyses provided information on the conditions for this association. Although based on small sample sizes, our analysis of the displacement hypothesis revealed underlying processes that require additional consideration in future studies.

Manuscript #3 investigated correlates of social media use on a higher level. It summarized recent meta-analytic evidence related to several variables which have been connected to social media use in the public discourse. First, higher social media use was slightly connected to lower wellbeing, indicated by higher loneliness and depression as well as lower life satisfaction and self-esteem. The more time people spent using social media, the lower their reported wellbeing. Second, consistent with Manuscript #1, two other meta-analyses found small negative associations between general SNS use and academic achievement. The more an individual used SNS, the lower his or her reported grades. Third, higher use of social media was connected with higher narcissism scores. People who reported more SNS use also reported that they were more narcissistic. Most of these meta-analytic effects were small, accounting for less than 4% of the variance. Manuscript #3 therefore concluded that – apart from grandiose narcissism – the effects are significant, but social media use clearly does not explain enough variance of the investigated correlates to give rise to alarm. Individual and context factors have more impact on variables like well-being. Moreover, Manuscript #3 pointed to relevant moderators for each of the correlates. In

addition to individual factors such as age, gender, or cultural background, differences in the measures and SNS usage patterns caused changes in the mean relationships.

In summary, Manuscript #3 reviewed the existing meta-analytic literature on social media and several correlates. The review provided conclusive information on the research of social media effects on a more general level but also details on these effects through moderator analyses. The manuscript underscores the importance of effects being interpreted appropriately (e.g., in cases of small effect sizes).

5.1.2 Limitations of the three manuscripts and outlook

The rather small size of the identified effects is a common phenomenon in studies of media psychology. Unsurprisingly, the meta-analytic effects are also often small. Because of the bigger sample size, significance tests are more sensible (Lin, Lucas, & Shmueli, 2013) and even small effects (e.g., $d < .10$) can reach the significance threshold. Apart from analyzing the significance of effects, researchers should communicate the actual impact of the discovered effect (e.g., Sullivan & Feinn, 2012). An effect that explains less than 1% of a certain variable, should not be treated as its main antecedent. For example, video gaming explained less than 1% of the variance in body mass (see Manuscript #2). The amount of attention media effects gain should therefore be in relation to the bigger interplay of the independent variables which determine a certain depending variable. Average media use may have an impact, but the influence is often too small to give rise to concern. Addictive media use, however, was not the topic of the presented manuscripts and is not included in these concluding statements.

The three manuscripts were essential for addressing the questions asked. However, like all methods, meta-analyses also suffer from limitations that also affect the manuscripts. First, they were all based on cross-sectional studies. Their effect sizes are shown only by correlations between the variables, without causal implications. The processes underlying

these relationships are still inconclusive. The three manuscripts do not clearly reveal a certain effect direction between the variables. However, this limitation can be addressed by further research, first by conducting longitudinal or experimental designs and further meta-analyses of the longitudinal or experimental effects. Second, all meta-analyses depend highly on the existing literature. Hence, some questions on underlying processes and moderating variables could not be answered within the three manuscripts. For example, the processes explaining the association between video gaming and body mass are still unclear. There are indications that physical activity may be a mediator, but this was only a first step. Dietary behavior or ethnicity have also been associated with video gaming (e.g., Hernandez, Reesor, & Murillo, 2017; Mu, Xu, Hu, Wu, & Bai, 2017), but they have not been tested meta-analytically. For video gaming and social media use, sleep could be a central moderating variable. Sleep quality decreased in individuals due to different digital media uses (e.g., Arora, Broglia, Thomas, & Taheri, 2014; Carter, Rees, Hale, Bhattacharjee, & Paradkar, 2016). With regard to academic achievement, lower sleep quality has been found to impair cognitive performance (e.g., Dewald, Meijer, Oort, Kerkhof, & Bögels, 2010). Concerning mental health, sleep plays a central role for depression or anxiety (e.g., Gregory et al., 2011). Social media and addictive smartphone use have been related to lower sleep quality as well as to lower achievement and self-esteem, higher depression, and more anxiety (e.g., Demirci, Akgönül, Akpınar, 2015; Woods & Scott, 2016). Hence, sleep should be considered a central moderating variable for digital media effects and included in future studies. Although the manuscripts provide some hints on moderating effects, not all relevant variables have been investigated. The underlying processes of media correlates are still to answer.

Thus, there are some unanswered questions, pointing out the areas where research is still missing. The evidence on sleep associated with digital media use and with the psychological variables (e.g., health, wellbeing, or academic achievement) seems promising. The processes explaining body mass still needs to be further investigated in future studies.

Primary studies with a high amount of information (e.g., control and moderator variables) would allow extensive moderator analyses. Such findings could help with the development of theories and models. Due to new methods such as the MASEM (Cheung, 2015; Cheung & Hong, 2017), different variables can be included in one model on a meta-level. Even though single studies cannot combine all relevant variables, meta-analyses can. Moreover, the method of network meta-analyses aims at testing all relevant variables as well as the direct and indirect effects on a certain outcome in one model (see Higgins & Welton, 2015). This approach could be promising for the development of theories and models explaining the interplay of several factors of media use.

5.1.3 Conclusion for the implications of the three manuscripts

To conclude, the three manuscripts considerably extend the literature on media effects. The overall findings indicate that there are no reasons to have strong fears about media effects. Even when significant relationships were present, the corresponding effect sizes were small to moderate. The impact of new media on the everyday life should not be overestimated. Negative labeling or pathologizing of usual (non-addictive) media use is not purposeful. Moreover, media use can have positive effects (e.g., on social capital) which should be kept in mind. If individuals use new media responsibly and consciously, the media support them with their everyday tasks (e.g., by building social capital using SNS, see Manuscript #3) and possible negative effects could be reduced (e.g., on self-esteem though thin body ideal, see Manuscript #3).

5.2 Meta-analysis: A method for media psychology?

Meta-analyses can be performed in very different research areas, but are more common in – for example – clinical contexts. In studies of media psychology, the settings might differ from medical studies, and meta-analyses might be subject to other problems. Media psychology is a rather new discipline, and many measures are not standardized (e.g.,

ad-hoc items for measuring media use). Moreover, media stimuli used in experiments (e.g., news articles, movies, etc.) differ a lot and cannot be as easily classified as, for example, medical treatments. This dissertation project also aimed to identify the benefits, limitations, and possible particularities of using meta-analyses in media psychology.

Based on the results of the three manuscripts, there are clear benefits of meta-analytic summaries for the research of media psychology. First, an overall effect size quantifies the amount of media effects. Such overall effect sizes can help scholars to draw conclusions on the influence of new media in everyday life. Properly communicated, these results can help parents, teachers, and governments to decide if restrictions of digital technology (e.g., for children) are necessary or not. Second, by conducting sensitivity and moderator analyses, we learn more about the underlying processes and the conditions under which media effects happen. As the body of meta-analytic evidence grows, we might even be able to identify moderators that repeatedly appear in single studies (e.g., sleep quality) and to develop theories and models for digital media use and its effects. Third, meta-analyses are able to determine the degree of complexity of a certain topic and to identify the areas where further research is needed (e.g., through moderator analyses). Fourth, meta-analyses enable the detection of methodological problems: for example, a bias due to preferred reporting of significant results as well as differences arising from the type of analyses or the use of certain instruments, measures, or stimulus material. Fifth, especially in media psychology, meta-analyses highlight the need for differentiated instead of generalized statements about media effects and are able to provide comprehensive conclusions.

In spite of these advantages, the use of meta-analyses is also subject to limitations. Due to different sources of biases (e.g., measurement error, study quality), meta-analyses can be imprecise (Bangert-Drowns, 1997; Lakens, Hilgard, & Staaks, 2016). Recent studies have shown that the replicability of meta-analytic results is limited (Lakens et al., 2017). The

method itself is sophisticated and can be challenging, which leads to mistakes in its application (Gøtzsche, Hróbjartsson, Marić, & Tendal, 2007). In the process of conducting meta-analyses, different decisions have to be made (e.g., which studies to include), which can lead to different results, although the method is correctly applied. The example of violent video games (see Chapter 1.4.2) illustrated how several meta-analyses on the same topic can report different results, which can be partially attributed to the decisions on which data to include (e.g., inclusion of beta-weights, see Ferguson, 2015; Rothstein & Bushman, 2015). Although Manuscript #3 showed that the meta-analyses reported consistent overall effect sizes, there were differences in their strategies (e.g., testing of moderators), study inclusion, and results of the moderator analyses. These problems, however, may occur in every field and are not specific to meta-analyses in media psychology. However, some particularities are inherent to studies in this field. During the analysis of the data for Manuscript #1 and #2, differences in the measurements became apparent. First, there are few standardized scales for media usage and, if there are scales (e.g., the Facebook Intensity Scale, Ellison, Steinfield, & Lampe, 2007; Orosz, Tóth-Király, & Bóthe, 2016), they are rarely used in single studies. As a result, the measures vary considerably (e.g., video gaming measured based on a diary or a single item asking about yesterday's use). Although they show some content validity, it is not clear if they are comparable. Second, experimental studies often use media stimuli (e.g., video games, movies, fictional social network sites). These stimuli can differ a lot, although they are summarized under a certain label (e.g., a movie genre). Depending on the research question, this can be more or less relevant. In any case, the differences between the stimuli can be included as a moderator (e.g., which SNS: Facebook, Twitter, etc.), as long as the primary studies describe them in detail. Third, meta-analytic moderators or mediators provide a good possibility for detecting underlying processes. Yet, the information on possible variables has to be included in the primary studies investigated. Meta-analyses can only synthesize data. Primary studies should therefore provide detailed information on demographic variables (e.g.,

gender, age), but also possible covariates (e.g., study time or sleep when SNS and academic achievement are investigated).

While conducting the analyses described in the three manuscripts, we encountered both benefits and limitations. Overall, meta-analyses are very useful and highly promising for questions regarding media psychology. Nevertheless, previous single studies are often missing important information (e.g., the exact N for the relevant effect size). Standardized measures for media use should be developed and used consistently. In line with the open source movement (see Nosek et al., 2015), researchers should provide their data and all of the information needed to conduct a meta-analysis. New projects like *metaBUS* (Bosco, Steel, Oswald, Uggerslev, & Field, 2015; Bosco, Uggerslev, & Steel, 2017) or *MetaLab* (Tsuji et al., 2017) facilitate the process of executing meta-analyses. These projects collect studies and their data on a broad variety of topics (i.e., social sciences on *metaBUS* and cognitive development on *MetaLab*). Researchers can conduct different analyses directly at the websites. These projects support the use of meta-analytic data and the corresponding findings and are promising for theory development.

With more and more meta-analytic evidence, research might be able to communicate its findings more clearly. This may have the potential to temper heated debates about media effects and to prevent opinions from being shaped by fake news. Not only the science community may profit from meta-analyses, but also the general public. The following chapter will therefore discuss the next step for meta-analytic evidence: its dissemination.

5.3 What's next? – Science communication

This chapter comes back to the point where this project started: public discussions of media threats and research's contribution to them. To transfer the results of research to the general public it is necessary to understand the processes of science communication. Scientists have tried different strategies to communicate their results in the past. The

following chapter gives a short summary of the paradigms, theories, and empirical results regarding science communication. It also presents variables that determine how science is perceived and how likely people are to trust research results.

5.3.1 Communication of research findings

Over the last decades of science communication research, different paradigms that describe how science should communicate with the general public and disseminate its research findings have prevailed (see Bonfadelli et al., 2017). Today, the predominant paradigm describes public engagement with science (Leshner, 2003). In contrast to earlier paradigms (i.e., *scientific literacy*, Miller, 1983, 1992; *public understanding of science*, Bauer & Falade, 2014), there is no assumption of a knowledge deficit among the general public. The general public engages with science, and science may impact attitudes and beliefs (e.g., for the case of climate change, see Capstick, Whitmarsh, Poortinga, Pidgeon, & Upham, 2015). Under this paradigm it is important to look at the ways people process scientific information. Theoretical approaches in science communication are often transferred from general theories of media effect and can be classified on the macro- and micro-level (Metag, 2017).

5.3.1.1 Theories of science communication

Usually, processing scientific information is mediated by media reports. Most people probably do not read direct scientific publications but read newspaper articles that describe new scientific findings. With the internet, there are even more possibilities of becoming informed. Hence, media effect theories, such as the agenda-setting theory (see McCombs & Shaw, 1972), the cultivation theory (see Gerbner & Gross, 1976), the knowledge gap hypothesis (Tichenor, Donohue, & Olien, 1970), or the spiral of silence theory (Noelle-Neumann, 1989), have been deployed on the macro-level. The application of these theories to science communication lead to a gain in knowledge. For example, scientific topics included in the agenda of mass media were able to change the knowledge of people and their opinions on

the topic (Bonfadelli, Dahinden, & Leonarz, 2002). Knowledge gaps were found between different communities (Nisbet, Hart, Myers, & Ellithorpe, 2013), but could be closed with the help of the internet (Cacciatore, Scheufele, & Corley, 2014). The mediating role of the mass media for controversial topics such as media effects was relevant for the spiral of silence theory (Brossard, 2009).

On the micro-level – the level of the recipients – individual differences determine how people interact with media reports and information about scientific findings. First, different processes of media use influence interest, knowledge, or opinions on science as well as trust in science and scientists (e.g., Dudo et al., 2011; Retzbach & Maier, 2015). Second, especially for controversial topics (e.g., vaccines), research highlights the importance of individual differences such as political ideologies (Baumgaertner, Carlisle, & Justwan, 2018) or personality variables, such as the need for cognition (Winter & Krämer, 2012). Such processes behind media effects have been summarized in different models. For example, the Integrated Model of Communication Influence on Beliefs describes these processes, including predictors of media use (e.g., values), media use itself and processing of information (e.g., counter arguing) as well as the effects on beliefs (Eveland & Cooper, 2013). According to a meta-analytic review, the risk information seeking and processing model (RISP; Griffin, Dunwoody, & Yang, 2012) is supported by over 13 studies (Yang, Aloe, & Feeley, 2014). It includes individual characteristics (e.g., values and attitudes) as well as affective and motivational factors that predict information seeking and processing behaviors (Griffin et al., 2012). Gollwitzer and colleagues (2014) provided an overview about biased presentations and perceptions of video game research with the example of the violent video games debate. The proposed interplay of variables included systematic biases at three stages: (1) research funding, (2) journalistic presentations, and (3) recipient characteristics. Journalistic presentations of social science can be biased, because complex research results have to be abbreviated and simplified. Scientific information can be a threat to the values or social

identity of readers, which therefore affects how news reports are processed (Gollwitzer et al., 2014).

Most research on science communication and information processing has investigated topics closer to the natural sciences, such as technology, physics, or biology (e.g., climate change). Topics of the social sciences are closer to everyday life (e.g., impact of video gaming on students) and may be more accessible for individuals than, for example, the direct consequences of climate change. According to the exemplification theory (Zillman 1999; Zillmann & Brosius, 2012), personal experiences that are described in newspaper articles, but also in social media or blogs, may have a stronger impact on attitudes and beliefs than actual research results (e.g., Kim, Namkoong, Fung, Heo, & Gunther, 2018; Zillman, Gibson, Sundar, & Perkins, 1996). Especially when individuals report on health risks (e.g., violence or depression), the effects of the narratives about their individual cases have been documented (Spence, Westerman, & Rice, 2017).

5.3.1.2 *Conclusion*

One of the most challenging aspects in communicating science results is the complexity of research results. In most cases a question is not answered with a simple “yes” or “no”, but with an “it depends” (e.g., in Manuscript #1). Popular books describe alarming scenarios (e.g., Carr, 2011; Spitzer, 2012, 2015), and media articles have followed the trend of using catchy titles (e.g., Naughton, 2018). When information provided in the form of personal stories and popular books is one-sided and scientific articles are hard to understand, there is a need for a mediator. Journalists usually fulfill this function. They read scientific papers, summarize their findings, and describe them in a comprehensible manner for everyone. They have to understand the scientific articles and be able to reflect on the complexity and changeability of scientific evidence. Their readers, however, need an open mind for ambiguous results and need to be willing to read two-sided articles. Chapter 1.1

described the alarming tone often present in popular literature, newspapers, and social media. Fortunately, there is also critique of one-sided books (Wisnioski, 2015), and some authors present the complexity of scientific evidence (Boyd, 2014). Findings on science communication have shown that laypersons prefer two-sided articles and are open to research's complexity (Winter & Krämer, 2012).

As described in Chapter 5.3.1, the current paradigm of science communication emphasizes public engagement with science, according to which people actively search scientific information, especially using the internet. How people process research results depends on the way journalists present them and an individual's characteristics (Gollwitzer et al., 2014). Most findings of science communication are based on the communication of single studies. It is still unclear if there are differences between the journalistic processing and public understanding of single studies versus meta-analyses.

5.3.2 Meta-analyses and science communication

Even when journalists report a study's findings correctly, it might not reflect all of the whole research on a certain topic. For example, a study reporting positive effects of video gaming on academic achievement (Posso, 2016) received extensive exposure in newspapers (e.g., Bodkin, 2016; Gibbs, 2016; Griffiths, 2016). However, a subsequent meta-analytic summary showed contradicting evidence when all studies on this topic were included (Gnambs, Stasielowicz, Wolter, & Appel, 2018). It is unclear as to whether the mechanisms of science communication are the same for different types of studies, e.g., single studies versus meta-analyses. Meta-analyses synthesize previous and heterogeneous research. They therefore might be able to reduce complexity. They also create coherence for topics with conflicting views. Stadtler and colleagues (Stadtler, Scharrer, Brummernhenrich, & Bromme, 2013; Stadtler, Scharrer, Skodzik, & Bromme, 2014) reported that it was easier for individuals to identify conflicts by consulting different documents. However, when seeking

information people do not always consider several sources. Sometimes their search ends after finding an article consistent with their opinion (i.e., confirmation bias, e.g., Knobloch-Westerwick & Meng, 2009). Meta-analyses might be able to prevent confirmation bias, because they summarize a large body of research, including opinion-consistent but also contradicting information. Meta-analyses are useful for journalists writing articles, because they already summarize existing literature.

Moreover, in the process of opinion-formation, meta-analytic results might have more weight than a single study. They are based on a bigger sample size and are able to correct errors from single studies. It seems reasonable that – when correctly conducted – their results are more reliable. However, it is not clear how comprehensible the method is and how much explanation should be included when meta-analytic evidence is presented in, for example, newspaper articles. Moreover, meta-analyses do not necessarily provide a clear answer on a certain question. They provide information on moderating and mediating effects that help with the building of models of media effects. However, such results might remain complex. The three manuscripts showed that there is no black and white for media effects. They are not devastating, but also not only beneficial. Media effects still depend on various factors, which may or may not become clearer through the communication of meta-analyses.

Personal evidence is much more likely for media use. People use media devices themselves and, therefore, generate hypotheses on their possible effects. For example, the feeling of transportation (e.g., in a YouTube video or a chat conversation on the phone) might lead a recipient to forget his or her environment. Although this effect is quite normal, people tend to believe that others (e.g., their children or adolescents) are more strongly influenced (i.e., third-person-effect; Davison, 1983) and might therefore be concerned about the rise of smartphone zombies (Schmidt, 2016). Additionally, the exemplification theory (Zillmann, 1999; Zillmann & Brosius, 2012) underscores the importance of individual experiences (e.g.,

Kim et al., 2018). At this point it could be possible that the stronger weight of meta-analyses enables them to have more impact than such narratives.

5.3.3 Outlook

Meta-analytic evidence could be beneficial for science communication, but research on its processing and impact is still in its infancy. Three questions remain for further science communication research: Can meta-analytic summaries reduce the complexity of research findings? Is the concept of meta-analyses easy to understand in the sense of a higher weight of meta-analytic evidence? And can meta-analytic evidence surpass exemplification and personal evidence?

Apart from meta-analyses, recent literature connected new media in general to science communication (e.g., Brossard & Scheufele, 2013). The internet has brought about big changes in the information-seeking behavior of individuals (e.g., Krämer & Winter, 2014; Nisbet & Scheufele, 2009). Individuals benefit, for example, from information that comes directly from researchers (Littek, 2012). To contribute to science communication, a website has been designed to disseminate the results of the manuscripts and further meta-analytic evidence (see <https://meta-internet.com>). The meta-analytic evidence on new media effects will be presented in a comprehensible way. The information provided, aims at simplifying access to research findings for journalists, parents, teachers, and other interested individuals.

5.4 Conclusion

Digital media have been accused of making people “fat, stupid, aggressive, lonely, sick and unhappy “(Spitzer, 2012, pp. 325). Such concerns are widely spread and discussed online. On the one hand, new media are beneficial. New technologies are designed to simplify everyday tasks (e.g., GPS navigation, cloud storage). On the other hand, they can have negative effects (e.g., data security, effects on psychological variables). Researchers have conducted a large body of studies, addressing the concerns of the general public. Due to the

complexity of media use, these studies often show heterogeneous results, impeding a clear conclusion on media effects. Meta-analyses are one of the most suitable approaches for summarizing existing evidence. They make it possible to draw conclusions on concrete questions or to detect research gaps. Especially for complex associations, meta-analyses help to identify open questions. (i.e., moderating variables).

The presented manuscripts address the topic of popular media fears with the method of meta-analytic review. They add substantial knowledge on the correlates of social media use and video gaming. However, their answers are not black or white. The meta-analytic associations varied in size and effect direction depending on various factors, such as usage of media, but also on personal or situational variables. Associations with media use are often small, and so were the meta-analytic effects. Moreover, meta-analyses are also limited, for example, to analyzing existing evidence. In summary, meta-analyses are valuable but not necessarily superior to other methods. To analyze effects in the field of media psychology, they are very promising. Also, meta-analyses might be helpful for transferring research results into public discussions. Nearly everyone has personal experience with new media – either through their own use or by observing the use of others. When popular authors (e.g., Carr, 2011; Greenfield, 2015) and news media highlight only studies with negative effects, it is important to provide comprehensible overviews that include all scientific findings. Meta-analyses can provide such overviews. They can support knowledge building by providing an overall picture of media effects. However, the concrete benefits of meta-analyses for science communication still need to be explored.

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Appendix A: Supplement and additional Material of Manuscript #1

Table S1

Country, number of studies from the country included in the meta-analyses, HDI value, and HDI category.

Country	Number of Studies	HDI value (category)	Meta-analysis
China	1	0.719 (high developed)	General measures
Croatia	1	0.812 (very high developed)	General measures Multitasking Academic purposes
Ethiopia	1	0.435 (low developed)	General measures
EU	2	0.738 (very high developed)	General measures (2) Multitasking (2)
Ghana	1	0.573 (medium developed)	General measures
Hong Kong	2	0.719 (high developed)	General measures
Iran	1	0.749 (high developed)	General measures
Jordan	1	0.715 (high developed)	General measures
Kuwait	1	0.814 (very high developed)	General measures
Malaysia	2	0.773 (high developed)	General measures
New Zealand	2	0.910 (very high developed)	General measures
Nigeria	4	0.504 (low developed)	General measures
Pakistan	2	0.537 (low developed)	General measures
Philippines	1	0.660 (medium developed)	General measures
Sweden	1	0.898 (very high developed)	General measures
Taiwan	1	0.719 (high developed)	General measures Academic purposes
Thailand	2	0.722 (high developed)	General measures (2) Academic purposes (2)
Tunisia	1	0.721 (high developed)	General measures
Turkey	2	0.759 (high developed)	General measures (2) Multitasking (1) Academic purposes (1)
USA	30	0.910 (very high developed)	General measures (26) Multitasking (11) Academic purposes (5)

Notes: HDI categories based on the United Nations Development Programme (2016). Very high developed HDI ≥ 0.800 , high developed HDI = 0.700-0.799, medium developed HDI = 0.550 – 0.699, low developed HDI ≤ 0.550 .

United Nations Development Programme (2016). *Human Development Index and its components*. Retrieved from <http://hdr.undp.org/en/composite/HDI>.

Supplementary Material: Funnel Plots

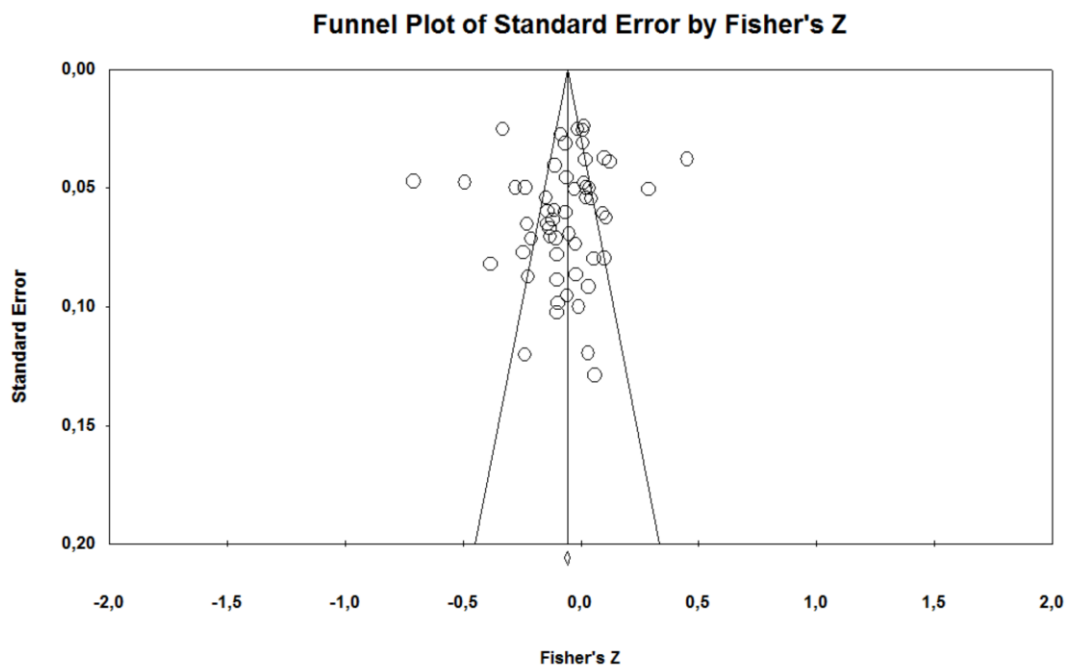


Figure S1. Funnel plot pertaining to the general SNS use meta-analysis

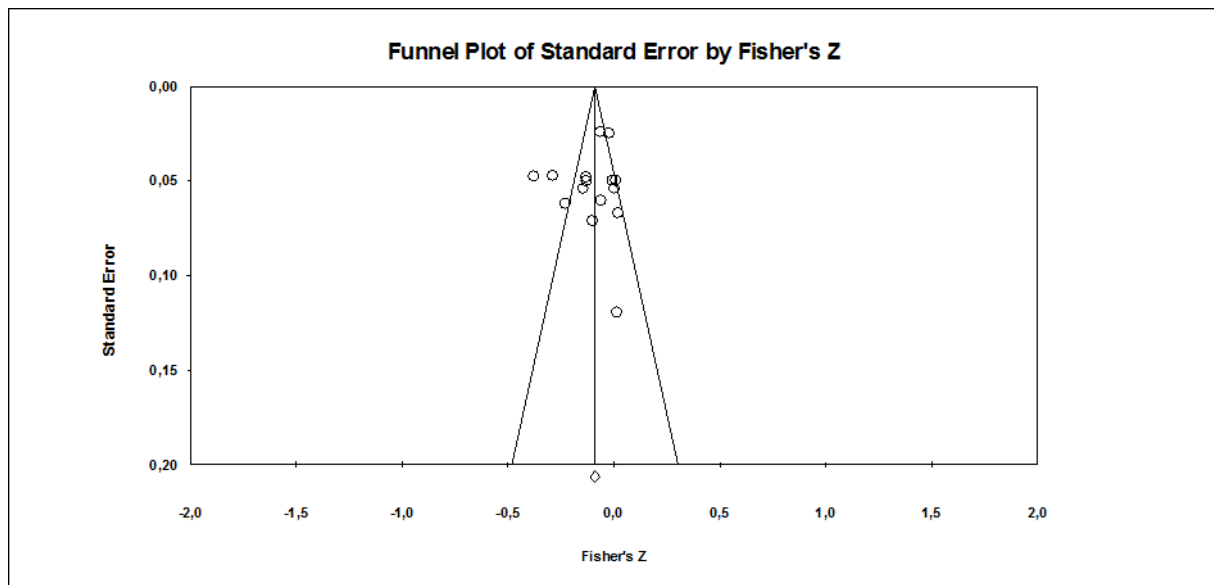


Figure S2. Funnel plot pertaining to the multitasking SNS use meta-analysis

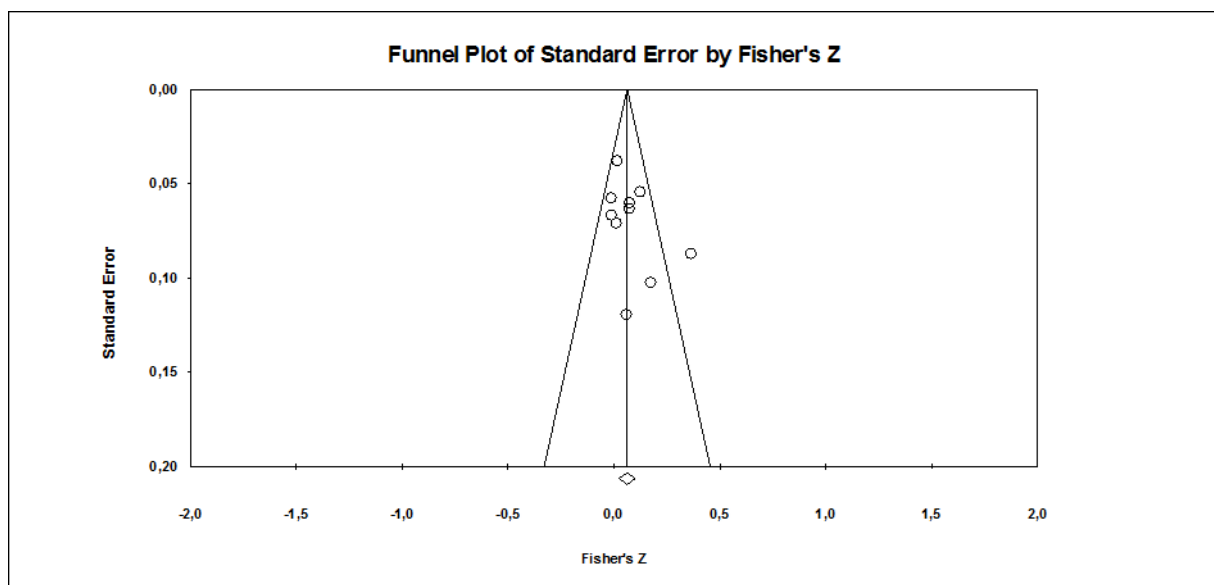


Figure S3. Funnel plot pertaining to the SNS use for academic purposes meta-analysis

Codebook

Academic Achievement and Social Network Sites

CAROLINE MARKER / MARKUS APPEL

Eligible criteria:

- a. Use of a social network site
 - i. Frequency
 - ii. Intensity rating
 - iii. Activities (log-ins, number of friends or posts)
 - iv. Comparison of SNS-users and non-users
- b. Objective academic achievement measure
 - i. GPA
 - ii. Self-reported grades
 - iii. Tests
- c. Reports correlation or comparable information
- d. Sample: all samples
- e. Design: experimental, cross-sectional, longitudinal
- f. All nationalities
- g. All publication types
- h. Time frame: none
- i. Experiments with SNS use for academic purposes and subjective achievement/academic success

Exclude:

- a. Non-SNS-activities like blogging, online discussion forums, e-learning, instant messaging, etc.
- b. Studies with evaluative focus on SNS-use like motivations, emotions and attitudes as well as SNS addiction.
- c. Studies that only report how much SNS one uses and how long they have an account (doesn't mean that they using it).
- d. Studies that only report student engagement, but no exact measure of academic achievement.

Variable	Description	Value	Example
<i>General characteristics</i>			
Studyname	Name of the Study as first author and year of publication. If there are studies with the same author and year, add a running letter. The name should clearly identify the study.	open	carlbring2007 carlbring2007a
subgroups	Name of subgroup (i.e. men vs. Women) the following data came from. To be used in case, when no overall values are presented. For example the authors only present separated correlations for men and women or for different nationalities or for different ages.	open	women
StudyID	Running number. For identification across different documents. Has to be <u>the same</u> in all documents like the Excel-sheet and CMA.		
pubyear	Year of publication	open	2007
Pubyears	Category of publication year	1 = 2009 – 2011 2 = 2012 – 2014 3 = 2015 – 2016	2
<i>Effects</i>			
r	Correlation of SNS use and academic achievement. Use this column only for zero-order correlations, not for partial correlations, beta-weights, etc.	[-1, 1]	.30
N	Samplesize N	[2, ∞]	100
rpart	Correlation of SNS use and academic achievement. Use this column only for partial correlations and only if zero-order correlations are not available	[-1, 1]	
β	Use this column to code β , if no correlation is reported. If possible, use β without other predictors (like age or gender). All β -values have to be converted for the cma program.	[-1, 1]	-.05

Convert- β	Converted β -value. Formula by Peterson & Brown (2005): $r = \beta + .05\lambda$ ($\lambda = 1$ if β is non-negative; $\lambda = 0$ if β is negative)	[-1, 1]	-.05+.05*0= -.05
order	Are the effects reported in the study independent from other variables (zero-order) or are they confounded with other variables (partial correlations or regression weights)	1 = zero-order 2 = (semi-)partial	1
Other	If no correlation and β values are reported, code other values reported (i.e. t-value).	Open	t (8)=2.89, p = 0.020
<i>General characteristics (continued)</i>			
colyear	Year of data collection (if available)	open	2007
centry	Country of data collection. If not reported take country of first author's affiliation. Code as ISO-CODE 2: http://en.wikipedia.org/wiki/ISO_3166-1_alpha-2	open	DE
HDI	Human Development Index. Table available here: http://hdr.undp.org/sites/default/files/hdr14-report-en-1.pdf p. 238 Category 1 = Values 1-49; Category 2 = Values 50-102; Category 3 = Values 103-144; Category 4 = Values 145-187	1 = Very high developed country 2 = High developed country 3 = Medium and low developed country	2
lang	Language of questionnaire	1 = English 2 = German 3 = other (Chinese, Korean, French, etc.)	1
pubtype	Publication type	1 = Peer-reviewed Journal 2 = Book 3 = Thesis (Master / PhD) 4 = Other	1

Published	Was the study published through a peer-reviewed journal or not?	1 = published 2 = unpublished	1
Design	Study design	1 = cross-sectional 2 = experimental 3 = longitudinal	2

Variable	Description	Value	Example
<i>Sample</i>			
sampletype	Description of sample (coded)	1 = mostly adolescents, school up to 12th grade 2 = mostly undergraduates, college students 3 = mostly adults / different academic levels	2
sexN	N of women	[0, ∞]	40
age	Mean age of participants	Open	16.86

Variable	Description	Value	Example
<i>SNS-use</i>			
SNSname	Name of SNS used in the study	1 = Facebook 2 = StudiVZ 3 = MySpace 4 = Twitter 5 = Renren oder Weibo (Chinese) 6 = other, not specified or more than one	1
SNSuse	Specified SNS construct measured (i.e. number of friends or posts, kind of activity on SNS)	Open	Facebook intensity scale
SNScon	Specified SNS construct measured (i.e. number of friends or posts, kind of activity on SNS)	1 = Time for SNS absolute (i.e. h/day) 2 = number of checking/log-in 3 = measure of general activity/intensity (subjective evaluation) 4 = multi-item measure of activity (different activities in one global value) 5 = particular activity (i.e. number of posts, uploading pictures, writing comments, posts on other people's walls, messaging, reading posts of others) 6 = Facebook Intensity Scale (FBI, Ellison) 7 = length of texts (i.e. number of words of a commentary) 8 = number of friends 9 = SNS-use for academic purposes 10 = multitasking use of SNS 11 = Other (name in notes)	2

Variable	Description	Value	Example
<i>Academic achievement</i>			
perform_instr	Instrument used to measure academic achievement or any kind of performance.	Open	GPA
perform_code	Code for used instrument to measure academic achievement	1 = GPA 2 = self-reported grades 3 = objective grades 4 = grade in particular exam (i.e. exam in psychology course the participants were recruited from) 5 = performance in exam designed for the study (i.e. test to measure English-skills for facebook-users and non-users) 6 = self-reported achievement 7 = subjective learning success (e.g. "understanding") 8 = other	1
Perform_rec	Recoded performance codes in two categories depending on the way of information gathering (as a self-report of the participants or e.g from a schools office)	1 = Self-reported achievement 2 = documented achievement	1

Variable	Description	Value	Example
<i>additional information</i>			
Other interesting variables	Are there other possibly relevant variables reported?	Open	Hours spent studying weekly

Moderator in primary study	Which moderators are reported? If there is no moderator, leave this column blank.	Open	Multitasking ability
notes	General commentaries. Everything that could be important to know.	Open	Reported no age mean, but range: 16 - 45
Origin of coefficient	Page and Table number of coded coefficient	Open	Table 2, p. 334 (8 in PDF)
Coded by	Initials of the coder	Open	CM

Appendix B: Supplement and additional Material of Manuscript #2

Table S1. Main Characteristics of the Primary Studies

No.	Study	Sample; Origin	% <i>female</i>	<i>Mean age in years</i>	<i>N</i>	Video gaming variable(s)	Body mass variable(s)	Effect sizes	Quality assessment
1.	Ballard et al., 2009	Undergraduates, college students; USA	0	19.54	116	V ₁ : Length of video game play during one sitting V ₂ : Frequency of game play	B ₁ : Objective BMI (kg*703/m ²) B ₂ : body fat percentage	V ₁ x B ₁ : <i>r</i> = .27 V ₁ x B ₂ : <i>r</i> = .11 V ₂ x B ₁ : <i>r</i> = .14 V ₂ x B ₂ : <i>r</i> = .15	2.33
2.	Dupuy et al., 2011, Sample 1 (male)	Adolescents; France	0	NA	3186	>2 hours/day vs. < 2 hours/day	Overweight (self- reported BMI: kg/m ² , cutoffs by IOTF)	OR = 1.1	1.67
3.	Dupuy et al., 2011, Sample 2 (female)	Adolescents; France	100	NA	3274	>2 hours/day vs. < 2 hours/day	Overweight (self- reported BMI: kg/m ² , cutoffs by IOTF)	OR = 0.97	1.67

4.	Foley et al., 2011	Mostly adolescents; New Zealand	NA	NA, age range = 10 – 18	935	Minutes/day	Healthy vs. obese (Objective BMI: kg/m ² , cutoffs by IOTF)	$r = -.01$	1.67
5.	Grydeland et al., 2012	Children; Norway	50.32	11.2	1103	Hours/day	Overweight/obesity (Objective BMI: kg/m ² , cutoffs by IOTF)	OR = 1.43	1.67
6.	Horn et al., 2001, Sample 1 (male)	Children; Canada	0	7.5	95	Frequency of VG	Objective measured subscapular skinfold thickness	$r = -.08$	1.33
7.	Horn et al., 2001, Sample 2 (female)	Children; Canada	100	7.4	103	Frequency of VG	Objective measured subscapular skinfold thickness	$r = .03$	1.33
8.	Jackson et al., 2011	Adolescents; USA	59.72	12.19	427	Frequency of VG	Self-reported BMI (lb/ft ²)	$r = -.03$	2

9.	Martinovic et al., 2015	Mostly children; Montenegro	49.33	10.2	4097	Hours/day	Overweight/obesity (Objective BMI: kg/m ² , cutoffs by IOTF)	OR = 1.11	1.67
10.	Mo-Suwan et al., 2014, Sample 1 (male)	Mostly children; Thailand	0	NA, age range = 6 – 14	2972	>1 hour/day vs. < 1 hour/day	Overweight (Objective BMI: kg/m ² , cutoffs by IOTF)	OR = 1.5	1.67
11.	Mo-Suwan, et al., 2014, Sample 2 (female)	Mostly children; Thailand	100	NA, age range = 6 – 14	3026	>1 hour/day vs. < 1 hour/day	Overweight (Objective BMI: kg/m ² , cutoffs by IOTF)	OR = 1.5	1.67
12.	Mwaikambo et al., 2015	Mostly children; Tanzania	54.76	NA, age range = 7 – 14	1722	> 1 times/week vs. < 1 times/week	Overweight/Obesity (Objective BMI: kg/m ² , cutoffs by IOTF)	OR = 2.3	1.33

13.	Pitrou et al., 2010	Children; France	50.68	8.2	1030	75 th percentile of hours/week vs. none	Overweight (parent-reported BMI: kg/m ² , cutoffs by IOTF)	OR = 1.09	1.67
14.	Scharrer & Zeller, 2014	Adolescents; USA	50.32	NA	176	V ₁ : Proportion of video gaming time V ₂ : Number of minutes per session	B: Self-reported BMI (lbs*703/in ²)	V ₁ x B: $r = .10$ V ₂ x B: $r = -.06$	2.67
15.	Siervo et al., 2014	Undergraduates, college students; United Kingdom	0	NA	45	V: Hours/week	B ₁ : Objective BMI (kg/m ²) B ₂ : Fat mass B ₃ : Waist circumference	V x B ₁ : $r = .30$ V x B ₂ : $r = .47$ V x B ₃ : $r = .42$	1.67
16.	Stettler et al., 2004	Children; Switzerland	47.02	NA	872	Hours/day	Overweight/ obesity (Objective BMI: kg/m ² , cutoffs by IOTF)	OR = 1.65	2.00
17.	Thomé et al., 2015 Sample 1 (male)	Undergraduates, college students; Sweden	0	21.9	2515	>2 hours/day vs. none	Self-reported BMI (kg/m ²)	OR = 1.7	2.33

18.	Thomé et al., 2015 Sample 2 (female)	Undergraduates, college students; Sweden	100	21.8	3806	>2 hours/day vs. none	Self-reported BMI (kg/m ²)	OR = 2.2	2.33
19.	Touchette et al., 2008	Children; Canada	54.50	6.00	1110	>1 h/week vs. <1 h/week	Overweight/ obesity (BMI: kg/m ² , cutoffs by Cole et al.,2000)	OR = 0.84	2.33
20.	Vandewater et al., 2004	Mostly children; USA	48.99	6.05	2831	Number of minutes (centered)	Percentile rank of BMI (parent reported weight/ documented height)	$r = -.02$	1.67
21.	Vicente-Rodríguez et al., 2008	Adolescents; Spain	49.33	NA	2842	Hours/weekend days	Body fat percentage calculated from objective measured skinfold	OR = 1.09	1.33
22.	Wack & Tantleff-Dunn, 2009	Undergraduates, college students; USA	0	20.48	219	Frequency of VG	Self-reported BMI (no details on calculation)	$r = -.05$	2.00

23.	Weaver et al., 2009	Adults; USA	52.72	44.7	552	Players vs. Non-Players	Self-reported BMI (no details on calculation)	$r = .13$	1.67
24.	Wijtzes et al., 2014	Children; Netherlands	NA	6.00	1043	V: > 1 hour/day vs. < 1 hour/day	B ₁ : Overweight B ₂ : Obesity (both through percent fat mass)	V x B ₁ : OR = 1.09 V x B ₂ : OR = 1.61	1.33

Notes. Children = up to 11 years old; Adolescents = 12 – 19 years old. Quality Assessment coding: 1 = Strong, 3 = Weak.

Table S2. Correlations between moderators

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
(1) Publication Year ^a	-							
(2) Adults vs. Children ^{c,d}	-.24							
(3) Adults vs. Adolescents ^{c,d}	.14	-.48*						
(4) Gender ratio in sample ^{a,b}	.05	.36*	.17					
(5) Gender differences in body mass	.11	-.54*	.50*	-.27				
(6) Self-reported BMI vs. objective BMI ^{c,e}	.10	.34	-.27	-.00	-.10			
(7) Self-reported BMI vs. other measures ^{c,e}	-.34	-.07	-.28	-.32	.00	-.35		
(8) Continuous vs. dichotomous body mass measures ^{c,f}	.29	.45*	.00	.48*	-.31	.33	-.48*	
(9) Quality	.18	-.51*	.23	-.31	.65*	-.05	-.11	-.35

Note.

^a centered

^b percentage females

^c dummy coding

^d reference group = adults

^e reference group = self-reported BMI

^f reference group = continuous measures

^g reference group = person product moment correlation/untransformed ES

* $p < .05$

Table S3. Pooled effects between video gaming and body mass depending on exclusion of studies

	k_1/k_2	N	Average Effect				Heterogeneity						
			Effect Size (ρ)	95% CI	(df) t	p	Q	df (Q)	p	$I^{2.3}$	$I^{2.2}$	$\sigma^{2.3}$	$\sigma^{2.2}$
Excluding outlier	19/31	36,375	0.073	[.017; .129]	(30) 2.65	.013	494.85	30	<.001	81.91	12.20	.012	.002
Including adjusted odds ratios	29/48	70,924	0.098	[.052; .144]	(47) 4.28	<.001	1035.30	47	<.001	75.77	20.48	.012	.003

Note. k_1 = Number of samples; k_2 = Number of effect sizes; $I^{2.3}$ = level 3 heterogeneity between studies; $I^{2.2}$ = level 2 heterogeneity between effect sizes; $\sigma^{2.3}$ = level 3 variance between studies, $\sigma^{2.2}$ = level 2 variance between effect sizes

Table S4. Moderator Analyses without outlier

Variable	<i>B</i>	95% <i>CI</i>	<i>SE</i>	<i>t</i>	<i>p</i>
Intercept	.23	[-.14, .59]	.17	1.29	.211
Publication Year ^a	.01	[-.01, .02]	.01	1.19	.247
Age Group					
Adults vs. Children ^{c,d}	-.14	[-.31, .02]	.08	-1.86	.077
Adults vs. Adolescents ^{c,d}	-.21	[-.37, -.05]	.08	-2.68	.014
Gender ratio in sample ^{a,b}	.01	[-.08, .10]	.04	0.22	.827
Gender differences in body mass	.00	[-.57, .57]	.29	0.01	.995
Body Mass Measure					
Self-reported BMI vs objective BMI ^{c,e}	.03	[-.09, .16]	.06	0.59	.564
Self-reported BMI vs. other measures ^{c,e}	.06	[-.10, .22]	.08	0.76	.458
Continuous vs. dichotomous body mass measures ^{c,f}	.03	[-.11, .17]	.07	0.48	.639
Study Quality Index	-.03	[-.21, .15]	.09	-0.37	.712
<hr/>					
$\sigma^{2.3} / \sigma^{2.2}$	0.007 / 0.003				
k_1 / k_2	19 / 31				
R^2	.24				

Note. $\sigma^{2.3}$ = level 3 variance between studies, $\sigma^{2.2}$ = level 2 variance between effect sizes; R^2 = Proportion of the random variance explained by the moderators; k_1 = Number of studies; k_2 = Number of effect sizes; ^a centered; ^b percentage females; ^c dummy coding; ^d reference group = adults; ^e reference group = self-reported BMI; ^f reference group = continuous measures.

Table S5. Moderator Analyses including adjusted odds ratios

Variable	<i>B</i>	<i>95% CI</i>	<i>SE</i>	<i>t</i>	<i>p</i>
Intercept	.22	[.09, .36]	.07	3.28	.002
Publication Year ^a	.01	[-.00, .02]	.01	1.64	.110
Age Group					
Adults vs. Children ^{c,d}	-.15	[-.28, -.03]	.06	-2.43	.020
Adults vs. Adolescents ^{c,d}	-.20	[-.32, -.07]	.06	-3.12	.004
Gender ratio in sample ^{a,b}	.03	[-.03, .09]	.03	0.94	.351
Gender differences in body mass	.27	[-.15, .68]	.20	1.30	.202
Body Mass Measure					
Self-reported BMI vs objective BMI ^{c,e}	.07	[-.02, .15]	.04	1.57	.124
Self-reported BMI vs. other measures ^{c,e}	.03	[-.12, .18]	.07	0.40	.694
Continuous vs. dichotomous body mass measures ^{c,f}	.03	[-.06, .12]	.04	0.58	.565
Study Quality Index	-.04	[-.09, .01]	.03	-1.66	.105
$\sigma^{2.3} / \sigma^{2.2}$	0.007 / 0.003				
k_1 / k_2	29 / 48				
R^2	.28				

Note. $\sigma^{2.3}$ = level 3 variance between studies, $\sigma^{2.2}$ = level 2 variance between effect sizes; R^2 = Proportion of the random variance explained by the moderators; k_1 = Number of studies; k_2 = Number of effect sizes; ^a centered; ^b percentage females; ^c dummy coding; ^d reference group = adults; ^e reference group = self-reported BMI; ^f reference group = continuous measures.

Table S6. Single Moderator Analyses

Variable	k_1 / k_2	B	95% CI	SE	(df) t	p
Publication Year ^a	20/32	.01	[-.00, .03]	.01	(2) 1.86	.072
Age Group	20/32					
Adults vs. Children ^{c,d}		-.10	[-.23, .03]	.06	(3) -1.58	.126
Adults vs. Adolescents ^{c,d}		-.20	[-.35, -.06]	.07	(3) -2.83	.008
Gender ratio in sample ^{a,b}	18/29	.01	[-.06, .08]	.04	(2) 0.35	.728
Gender differences in body mass	12/18	-.11	[-.61, .40]	.24	(2) -0.44	.663
Body Mass Measure	20/32					
Self-reported BMI vs objective BMI ^{c,e}		.07	[-.06, .20]	.06	(4) 1.07	.296
Self-reported BMI vs. other measures ^{c,e}		.08	[-.09, .25]	.08	(4) 0.97	.343
Continuous vs. dichotomous body mass measures ^{c,f}	20/32	.01	[-.13, .14]	.07	(4) 0.16	.873
Study Quality Index	20/32	-.03	[-.19, .14]	.08	(2) -0.35	.732

Note. k_1 = Number of studies; k_2 = Number of effect sizes; ^a centered; ^b percentage females; ^c dummy coding; ^d reference group = adults; ^e reference group = self-reported BMI; ^f reference group = continuous measures.

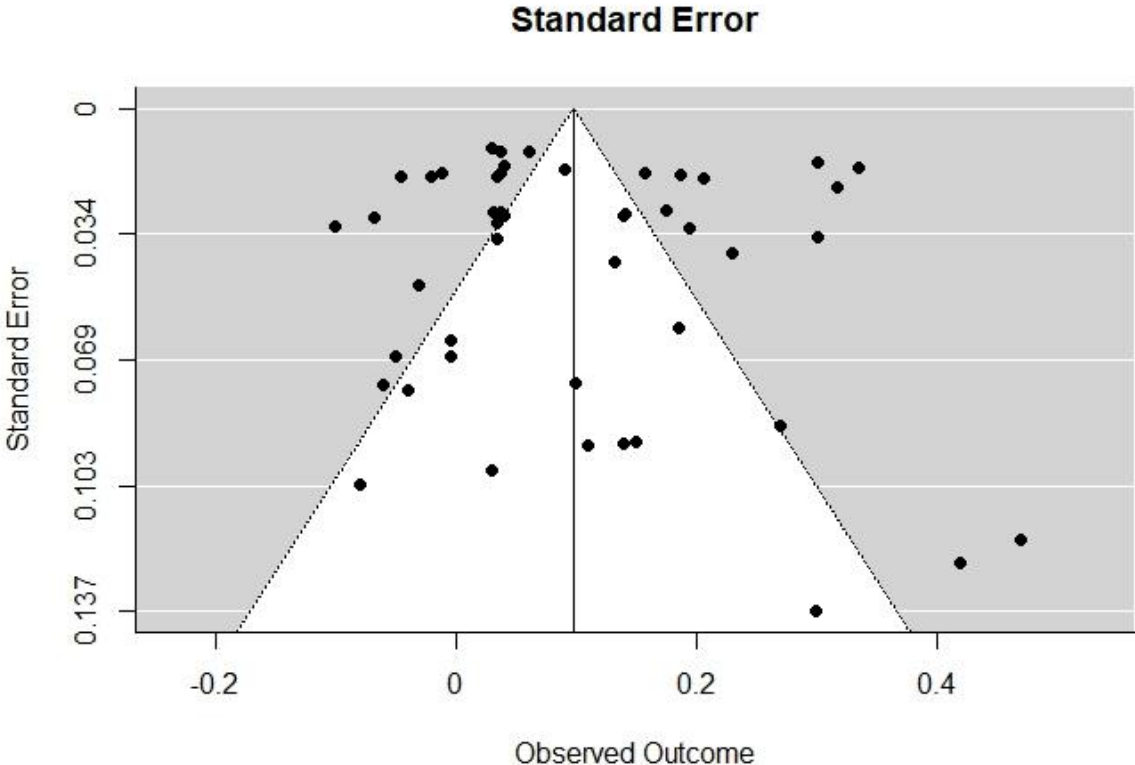


Figure S1. Funnel plot of the meta-analysis between video gaming and body mass.

Codebook

Exploring the myth of the chubby gamer:
A meta-analysis on non-active video gaming and body mass

Eligibility criteria:

- j. Measure of online/video/computer gaming
 - i. Frequency
 - ii. Intensity rating
 - iii. Gamer vs. non-gamer
- k. Measure of weight/fat mass
 - i. Body mass index (BMI)
 - ii. Fat mass
 - iii. Waist circumference
- l. Reports correlation or comparable information (e.g., odds ratios)
- m. Sample: all samples
- n. Design: experimental, cross-sectional, longitudinal
- o. All nationalities
- p. All publication types
- q. Time frame: none
- r. Language is English, German, or French

Exclude:

- e. Active video games/Exergames
- f. Media/Internet use or screen time
- g. Studies reporting no usable data (e.g., only second-order results like beta-weights reported)

Variable	Description	Value	Example
<i>General characteristics</i>			
Studyname	Name of the Study as first author and year of publication. If there are studies with the same author and year, add a running letter. The name should clearly identify the study.	open	carlbring2007 carlbring2007a
subgroups	Name of subgroup (i.e. men vs. Women) the following data came from. To be used in case, when no overall values are presented. For example the authors only present separated correlations for men and women or for different nationalities or for different ages.	open	women
<i>Effects</i>			
ES	All correlations of gaming and weight measure. Zero-Order correlations as well as converted correlations	[-1, 1]	0,30
r	Zero-order correlation of gaming and body mass measure.		
N	Sample size N	[2, ∞]	100
Odds.Ratio	Crude odds ratio (=zero-order).	[0, ∞]	1,50
Convert-OR	Converted odds ratios to correlations with the following formula: $\cos(\pi / (1 + OR^{0.5}))$	[-1, 1]	0,158
p-value	p-value of the reported effect	[0, 1]	.004
rgenderdiff	Correlation value for gender and BMI. A positive correlation indicates a higher BMI for boys, a negative correlation indicates higher BMI for girls.	[-1, 1]	0,010
<i>General characteristics (continued)</i>			
StudyID	Running number. For identification across different documents. Has to be <u>the same</u> in all documents.	Running study number	12
pubyear	Year of publication	open	2007

cntry	Country of data collection. If not reported take country of first author's affiliation. Code as ISO-CODE 2: http://en.wikipedia.org/wiki/ISO_3166-1_alpha-2	open	DE
lang	Language of questionnaire	1 = English 2 = German 3 = other (Chinese, Korean, French, etc.)	1
pubtype	Publication type	1 = Peer-reviewed Journal 2 = Book 3 = Thesis (Master / PhD) 4 = Other	1
Design	Study design	1 = cross-sectional 2 = experimental 3 = longitudinal	2

Variable	Description	Value	Example
<i>Sample</i>			
sampletype	Description of sample (coded). When a sample includes more than one coding group, take mean age (e.g., a sample aged 5 to 15, mean age is 10 -> mostly children).	1 = mostly children up to 11 y.o. 2 = mostly adolescents up to 19 y.o. 3 = mostly undergraduates, college students 4 = mostly adults / different academic levels	2
sexN	N of women	[0, ∞]	40
age	Mean age of participants	Open	16.86

Variable	Description	Value	Example
<i>Video Gaming</i>			
Game type	Type of game (e.g., console games, PC games, Facebook game). When coding 4 describe in parentheses.	1 = unspecified video gaming 2 = Console game 3 = PC game 4 = Facebook or app game 5 = MMORPG 6 = other or unclear	1
Game_instr	Instrument for measuring gaming	Open	Hours of gaming
Game code	Specified measure of gaming	1 = Time for gaming absolute (i.e. h/day) 2 = measure of general intensity (subjective evaluation) 3 = Frequency of gaming 4 = multi-item measure of intensity (different activities in one global value) 5 = Game Addiction 6 = Other (name in notes)	1

Variable	Description	Value	Example
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<i>Body Mass</i>			
weight_instr	Instrument used to measure weight status or any kind of body composition.	Open	BMI (kg/m ²). dichotomization by IOTF
weight_code	Code for used instrument to measure body composition	1 = self-reported BMI (continuous) 2 = self-reported BMI (dichotomized) 3 = documented BMI (continuous) 4 = documented BMI (dichotomized) 5 = documented non-BMI measure continuous (fat mass/body fat percentage or waist circumference) 6 = non BMI measure dichotomized 7 = other	1

Variable	Description	Value	Example
<i>additional information</i>			
QA	Value of the quality assessment	[1, 3]	1,33

Exploring the myth of the chubby gamer: A meta-analysis on sedentary video gaming and body mass

Modified Quality Assessment Tool for Quantitative Studies

The quality assessment tool was modified to fit for the type of primary studies. The original tool was published by the Effective Public Health Practice Project and can be accessed at <https://merst.ca/ephpp/>

- Section A is identical to the original tool
- Sections B, C, F, G, and H of the original tool were excluded because they were not applicable to the type of primary studies
- Sections D and E were adapted to represent the differences present in the primary studies:
 - Section D was renamed as “Section B - Disclosure of study’s purpose” and the section ratings were customized
 - Section E was included as “Section C – Data Collection Methods” and the section ratings were customized
 - Adapted section descriptions were originally in German and are marked with ^a
- We changed the global rating from categorical (i.e., either weak, moderate, or strong) to continuous (i.e., mean of the three section ratings)

A) Selection bias	Are the individuals selected to participate in the study likely to be representative of the target population?	1 Very likely
		2 Somewhat likely
		3 Not likely
		4 Can’t tell
	What percentage of selected individuals agreed to participate?	1 80 - 100% agreement
		2 60 – 79% agreement
		3 less than 60% agreement
		4 Not applicable
		5 Can’t tell
Section Rating A	The selected individuals are not likely to be representative of the target population (Q1 is 3); or there is less than 60% participation (Q2 is 3) or selection is not described (Q1 is 4); and the level of participation is not described (Q2 is 5).	WEAK (3)
	The selected individuals are at least somewhat likely to be representative of the target population (Q1 is 1 or 2); and there is 60 - 79% participation (Q2 is 2). ‘Moderate’ may also be assigned if Q1 is 1 or 2 and Q2 is 5 (can’t tell).	MODERATE (2)
	The selected individuals are very likely to be representative of the target population (Q1 is 1) and there is greater than 80% participation (Q2 is 1).	STRONG (1)

B) Disclosure of study's purpose	Was (were) the outcome assessor(s) aware of the intervention or exposure status of participants?	1 Yes
		2 No
		3 Can't tell
	Were the study participants aware of the research question?	1 Yes
		2 No
		3 Can't tell
Section Rating B	Participants were informed about aims and scope of the study. Only video gaming and body mass were measured, which would easily disclose the studies purpose and encourage the formation of hypotheses among the participants. ^a	WEAK (3)
	The study reports no information on the disclosure of its purpose. A lot of other variables are measured (e.g., general health and lifestyle), so that the hypothesis on video gaming and body mass is not too obvious. ^a	MODERATE (2)
	The study reports the use of a cover story and other variables are measured, so that the hypothesis on video gaming and body mass is not too obvious. ^a	STRONG (1)
C) Data collection methods	Were data collection tools shown to be valid?	1 Yes
		2 No
		3 Can't tell
	Were data collection tools shown to be reliable?	1 Yes
		2 No
		3 Can't tell
Section Rating C	Ad-hoc measures of video gaming and body mass, which miss acceptable content validity (e.g., time spent on video games only yesterday instead of a more representative time span). ^a	WEAK (3)
	e.g. self-reported BMI and retrospective amount of video gaming. ^a	MODERATE (2)
	Objective measures of body mass Representative measures for video gaming (e.g., Diary measures, differentiation between school days and week end). ^a	STRONG (1)
Global Rating	Mean of the section ratings ^a	WEAK (3)
		MODERATE (2)
		STRONG (1)
Is there discrepancy between the two reviewers	Yes / No	

If yes, indicate the reason for the discrepancy	Oversight	
	Differences in interpretation of criteria	
	Differences in interpretation of study	
Final decision of both reviewers	Mean of the section ratings^a	