



The Digital Media Use Effects Scales for adolescents (d-MUSE Scales): Conceptualization and validation of a screening tool

Stephanie Antons^{a,b,c,*}, Anke Heyder^d, Lena-Marie Precht^e, Elisa Wegmann^{a,b}, Magnus Liebherr^{a,c,f}, Julia Brailovskaia^{e,g}

^a Center for Behavioral Addiction Research (CeBAR), Center for Translational Neuro- and Behavioral Sciences, University Hospital Essen, University of Duisburg-Essen, Germany

^b General Psychology: Cognition, Faculty of Computer Science, University of Duisburg-Essen, Germany

^c Erwin L. Hahn Institute for Magnetic Resonance Imaging, Essen, Germany

^d Department of Psychology, Ruhr University Bochum, Germany

^e Mental Health Research and Treatment Center, Department of Clinical Psychology and Psychotherapy, Ruhr-Universität Bochum, Bochum, Germany

^f Department of Mechatronics, University Duisburg-Essen, Duisburg, Germany

^g DZPG (German Center for Mental Health), Partner Site Bochum/Marburg, Bochum, Germany

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ABSTRACT

The use of digital media is a crucial aspect of contemporary life for children and adolescents. Evidence suggests that digital media use can yield both positive and negative effects on well-being. Considering dual-factor models of mental health, a functional digital media usage pattern is characterized by low negative effects and high positive effects. Currently, there is no comprehensive measure assessing these effects of digital media use systematically across relevant life domains for adolescents' quality of life, i.e., "Physical Well-Being," "Mental Well-Being," "Peers & Social Support," "School Environment," and "Autonomy & Relationship with Parents." In an online survey ($n = 1001$, aged 16-18), we developed and validated the positive and negative Digital Media Use Effects Scales for Adolescents (d-MUSE-Scales) assessing the perceived effects of digital media use on well-being in different areas of adolescents' lives. The factor structure, scale properties, and construct validity of the d-MUSE Scales were satisfactory and aligned with expectations. The d-MUSE Scales have a broad application, spanning from basic research elucidating mechanisms related to digital media's effects to educational and preventive contexts, as well as diagnostic and treatment settings.

1. Introduction

The use of digital media is a central aspect of the contemporary world. Considering the first generation of 'digital natives' born between 1980 and 1994 (Bennett et al., 2008; Prenksy, 2001) we are now witnessing the upbringing of the third generation of children and adolescents surrounded by digital media. Digital media encompass a range of digital devices (e.g., smartphones, tablets, desktop computers) that support a variety of activities through specific applications, such as social media use, gaming, email communication, and streaming (Meier & Reinecke, 2020). Current data from Germany indicates that 99% of youths have access to smartphones, computers/laptops, and televisions, with a majority of them owning their own devices (e.g., 96% own a

smartphone) (Feierabend et al., 2023). Additionally, digital media are integrated into various aspects of life, including leisure time and school (Feierabend et al., 2023). This omnipresence of digital media is observable worldwide (OECD, 2024a; 2024b), implying a decreasing digital divide between individuals with access to digital media and those without. Nevertheless, factors such as gender, age, and education still influence access to digital media (Korovkin et al., 2023; Lopez-Sintas et al., 2020). While the one gap closes, new gaps might be opening up (Lythreatis et al., 2022). Today, it might be the effects of digital media use on well-being rather than the access to digital media that creates a gap between users: those who benefit from media use and those who experience severe negative effects of the use (Liebherr et al., accepted; Odgers, 2018). While there is variability in the effects of media use

* Corresponding author. Center for Behavioral Addiction Research (CeBAR), Center for Translational Neuro- and Behavioral Sciences (C-TNBS), University Hospital Essen, University of Duisburg-Essen, Hufelandstrasse 55, 45147 Essen, Germany.

E-mail address: stephanie.antons@uni-due.de (S. Antons).

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between individuals, most people also experience both positive and negative effects in their daily lives (Beyens et al., 2020). However, over the long term, persistent effects in one direction or the other may develop.

The current narrative in news and media regarding the impact of digital media on the lives of children and adolescents is predominantly negative: the use of digital media – especially extensive use – is reported to have a significant adverse impact on children and adolescents (Moreno & Radesky, 2023). Some young individuals indeed experience negative consequences due to their engagement in digital media, such as addictive videogame use (gaming disorder, ICD-11 code: 6C51; World Health Organization, 2022) or the effects of cyberbullying (Giumetti & Kowalski, 2022). Prevalence estimates of gaming disorder in children and adolescents range from 3.3% to 6.6% (Kim et al., 2022) and about 18% of college students reported cyberbullying victimization (Giumetti & Kowalski, 2022). These cases and negative consequences should not be overlooked.

Nevertheless, the world would not use digital media with such intensity if there were no additional positive effects. Accordingly, research indicates that the effects of digital media use might be more complex than portrayed in current news. This complexity becomes evident taking a closer look at associations between media use and well-being in adolescents (Liebherr et al., accepted). For instance, while cross-sectional studies indicate moderate to high negative associations between media use and well-being in adolescents (Santos et al., 2023), longitudinal studies suggest that these associations between digital media use and well-being (e.g., depressive symptoms) are small (Tang et al., 2021). Further studies highlight the positive effects on the life of children and adolescents (e.g., Haddock et al., 2022; Liebherr et al., 2020). Specifically, the use of digital media has been related to both positive feelings, such as fun and feelings of mastery, as well as a reduction of negative feelings, such as feeling less worried or lonely (Stoeber et al., 2011; Wegmann et al., 2022). Existing reviews suggest similarly inconclusive associations between digital media use and both well-being and psychopathology (Valkenburg, 2021; Valkenburg et al., 2022). Making the evidence even more complex, some studies indicated a non-linear association between digital media use and well-being (e.g., Przybylski & Weinstein, 2017). These effects might vary from person to person (Beyens et al., 2020) and the same usage pattern might have negative effects in one area of life (e.g., education) while having positive effects in others (e.g., social life).

Although functional digital media use has been a focus of research, there is currently no assessment tool available that measures the degree of functional digital media use in adolescents. For conceptualizing a functional use of digital media we refer to dual-factor models of mental health that propose that mental health is not only defined by the absence of illness but also by high levels of well-being as a second dimension (Greenspoon & Saklofske, 2001; Suldo & Shaffer, 2008). The term digital well-being also addresses subjective well-being in a social environment where digital media is omnipresent with its benefits and harms (Büchi, 2021). Similar to the definition of mental health and digital well-being, we argue that a functional use of digital media can only be considered present if the negative effects of media on well-being of children and adolescence are low and the positive effects are high.

These effects on well-being may manifest across various domains of life. There is currently no clear consensus on which specific domains are most relevant for determining quality of life. For adults, hundreds of domains have been identified through self-report measures, which can generally be grouped into seven themes: general well-being, mental well-being, spiritual well-being, physical well-being, activities/functioning, social well-being, and personal circumstances (Linton et al., 2016). Relevant domains for health-related quality of life in children and adolescents have been extensively explored and validated cross-culturally by the European KIDSCREEN initiative (Ravens-Sieberer et al., 2005; The KIDSCREEN Group Europe, 2006). Five key areas were identified as essential for assessing health-related quality of life in

children and adolescents: “Physical Well-Being,” “Mental Well-Being,” “Peers & Social Support,” “School Environment,” and “Autonomy & Relationship with Parents.” Accordingly, tools used to assess the impact of digital media on the quality of life of children and adolescents should address (1) both positive and negative effects (2) across these various dimensions.

Since the upcoming of digital media, several scales have been developed assessing the positive and/or negative effects of digital media on children and adolescents (see Table 1 for some examples). Typically, these questionnaires concentrate on one specific type of digital media use (e.g., gaming, social media, buying-shopping) with items being specific for the type of behavior (e.g., “I feel happy when I pass a level in online games”; Başol & Kaya, 2018; see Table 1). These specific items cannot be transferred to the use of other types of digital media, making comparisons between the perceived effects of different types of digital media impossible. Accordingly, these specific questionnaires do not account for the versatility of digital media (e.g., Başol & Kaya, 2018; Ferris et al., 2021; Jenkins-Guarnieri et al., 2013; Snodgrass et al., 2017). Some questionnaires target a particular form of use (e.g., addictive, aggressive, flourishing), that for example encompasses specific conceptualizations of pathologies such as behavioral addictions (Hong et al., 2012; Paschke et al., 2020; Rosić et al., 2022; Stodt, Wegmann, & Brand, 2018; Turel et al., 2011). Other questionnaires focus on one specific outcome area (e.g., physical, fatigue, values) without considering outcomes across multiple life domains (e.g., Bright & Logan, 2018; Hammer et al., 2021; Mylona et al., 2022). In questionnaires not directly focusing on positive or negative effects of digital media use on well-being, single items (sometimes subscales) within a multi-item scale explicitly ask for positive or negative perceived effects. For example, within symptom severity scales of Internet-use disorders, negative consequences of the behavior are assessed with one subscale besides other symptoms such as engaging in the behavior in a higher intensity as intended (e.g., Paschke et al., 2020; Turel et al., 2011) and not as detailed as the negative consequences might appear. Lastly, existing scales generally concentrate on either positive or negative effects, lacking a systematic assessment and balanced assessment of both positive and negative effects (e.g., Ferris et al., 2021; Wegmann et al., 2022). While these scales are important to assess specific outlets of digital media use, a comprehensive measure that systematically assesses both the positive and negative effects of digital media use on well-being in children and adolescents with regard to areas of life relevant for well-being (i.e., “Physical Well-Being,” “Mental Well-Being,” “Peers & Social Support,” “School Environment,” and “Autonomy & Relationship with Parents”) is missing. Even though it may be self-evident, it should be emphasized here that questionnaires can only capture the effects perceived by the user or others.

Similar to our argument that the positive and negative effects of digital media use should be separately and systematically assessed, a recently published questionnaire was designed to evaluate the digital well-being of adolescents in their everyday lives in a Slovenian sample (Rosić et al., 2023). Diverging from our understanding, the authors, however, conceptualized positive and negative effects as two sides of one dimension. Thus, each item was rated on a scale ranging from positive to negative effects (e.g., positive site (A): “Because of my smartphone use, I feel more relaxed”, negative site (B): “Because of my smartphone use, I feel more stressed”; response scale: 1 = *Very true of me (A)*, 2 = *True of me (A)*, 3 = *Partly true of me (A)*, *partly true of me (B)*, 4 = *True of me (B)*, 5 = *Very true of me (B)*). Accordingly, the measure fails to detect the degree of positive and negative within-person effects at the same time that may occur when considering different areas of life.

Based on this theoretical background and the limitations of previous scales, we aimed to develop a digital media use effects scale for children and adolescents, with this initial validation conducted in a sample of late adolescents. Accordingly, the aims of the study are:

Table 1
Examples of scales assessing positive and negative effects of digital media use in different domains.

Scales		Example items and areas of outcomes	
		Positive effects	Negative effects
<i>Specific type of digital media rowhead</i>			
Gaming	Snodgrass et al. (2017)	“Find that online gaming helps them relieve frustrations and improve their mood.” “Feel that gaming can give them focus and even purpose in life.”	“Find it difficult to concentrate on other activities because they are thinking about gaming.” “Use gaming to avoid challenges in their lives rather than deal with them directly.”
	Başol and Kaya (2018)	Success: “I feel happy when I pass a level in online games.” Economic profit: “I make money by selling the characters I created.”	Malfunctions: “I do not have a regular bedtime due to online games.”
Social media	Social media addiction consequences (Ferris et al., 2021)		Intrusive: “Would be more productive without using social media.” Emotional: “If I cannot use social media, I miss it so much that I am upset.”
	Social media use integration scale (Jenkins-Guarnieri et al., 2013)	Social integration and emotional connection: “Facebook plays an important role in my social relationships.” Integration into social routines: “I enjoy checking my Facebook account.”	
Specific application (e.g., buying-shopping, gaming, social media, porno graphy)	Experience of gratification and compensation scales (Wegmann et al., 2022)	While using a [specific application], I ... Gratification of needs: “feel close to others.” Experience of pleasure: “feel good.” Compensation of needs: “feel less unsuccessful.” Experience of relief from negative feelings: “feel less constricted.”	
Screen	Zoom Exhaustion & Fatigue Scale (Fauville et al., 2021)		General fatigue: “How tired do you feel after video conferencing?” Visual fatigue: “How blurred does your vision get after video conferencing?” Social fatigue: “How much do you tend to avoid social situations after video conferencing?” Motivational fatigue: “How much do you dread having to do things after video conferencing?” Emotional fatigue: “How emotionally drained do you feel after video conferencing?”
Smartphone	Perceived Digital Well-Being in Adolescence Scale (Rosić et al., 2023)	Because of my smartphone use, I ... Emotional domain: A) ... do fewer fun things. B) ... do more fun things. Social domain: A) ... feel more excluded from my friends. B) ... feel closer to my friends. Cognitive domain: A) ... do less of my daily tasks (e.g., schoolwork). B) ... do more of my daily tasks (e.g., schoolwork).	
<i>Specific types of digital media use rowhead</i>			
Addictive	ICD-11-based Gaming Disorder Scale (GADIS) for adolescents (Paschke et al., 2020) and parents (Paschke et al., 2021)		Negative consequences: “I often continue gaming even though it causes me stress with others (e.g., my parents, siblings, friends, partner, teachers).” “I continue gaming although it harms my performance at school/apprenticeship/job (e.g., by being late, not participating in class, neglecting homework, worse grades).” “Due to gaming, I neglect my appearance, my personal hygiene, and/or my health (e.g., sleep, nutrition, exercise).”

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Table 1 (continued)

Scales		Example items and areas of outcomes	
		Positive effects	Negative effects
	Consequences of addiction to organizational pervasive technologies (Turel et al., 2011)		<p>Addiction to mobile email: “I sometimes neglect important things because of my interest in my mobile email.”</p> <p>Technology–family conflict: “The use of mobile email keeps me from my family and friends more than I would like.”</p> <p>Work overload: “I feel that the number of requests, problems, or complaints I deal with is more than expected.”</p> <p>Organizational commitment: “For me, this is the best of all possible organizations for which to work.”</p> <p>Work–family conflict: “The demands of my work interfere with my home and family life.”</p> <p>Time management and its problem “Using mobile phone at night influences my sleep.”</p> <p>Academic problems in school and its influence “I neglect school work to spend more time on mobile phone usage.”</p>
Aggressive	Cyberbully Scale (Stodt, Wegmann, & Brand, 2018)		<p>Active perpetrator: “In the last six months, I bullied another person online.”</p> <p>Passive perpetrator: “In the last six months, I made a hurtful or embarrassing statement about another person on the internet by liking or sharing.”</p> <p>Victim: “In the last six months, I was cyberbullied online.”</p>
Flourishing	Digital Flourishing Scale for Adolescents (Rosic et al., 2022)	<p>Authentic self-presentation: “I allow people who I connect with online to see who I really am.”</p> <p>Civil participation: “When I talk to others online about politics (e.g., about the government, the President, elections), I know how to do it politely.”</p> <p>Positive social comparison: “Comparing myself to others online motivates me to accomplish the things I want in life.”</p> <p>Connectedness: “I feel part of a group when I communicate with others online.”</p> <p>Self-control: “For the most part, I feel in control of how much time I spend communicating with others online (e.g., chatting with friends, posting on Instagram, playing online games with others).”</p>	
Specific outcome of digital media use	rowhead		
Physical	Computer Vision Syndrome Questionnaire (Mylona et al., 2022)		<p>Adaption issues: “Frequently feeling dryness in the eyes.”</p> <p>Dry eye issues: “Blurred vision.”</p> <p>Posture issues: “Headache (not related to injury or migraine).”</p>
Value/costs	Parents beliefs about media use (Hammer et al., 2021)	<p>Intrinsic value: “I like using digital media.”</p> <p>Utility value: “Understanding digital media has many benefits in my daily life.”</p> <p>Attainment value: “Using digital media makes me a more knowledgeable person.”</p>	<p>Emotional cost: “When I deal with digital media, I get annoyed.”</p> <p>Opportunity cost “My reading and writing skills suffer because of using digital media.”</p>
Social media fatigue	Social media fatigue questionnaire (Bright & Logan, 2018)		<p>“I am likely to receive too much information when I am searching.”</p> <p>“The amount of information available on social media sites makes me feel tense.”</p>

- (1) generating items to assess positive and negative effects of digital media use based on the areas of life relevant for health-related quality of life in children and adolescents as identified by the KIDSCREEN (The KIDSCREEN Group Europe, 2006),
- (2) validating the factor structure of the questionnaire in a sample of late adolescents (aged between 16 and 18), and
- (3) exploring the construct validity.

Investigating the convergent construct validity for positive effects of digital media use, we expect (a) medium to high positive associations between positive effects of digital media use with scales assessing general quality of life and well-being (health-related quality of life, positive mental health, life satisfaction), general control over life and the use of media (sense of control, self-efficacy, internet use competence). Furthermore, we expect that a detailed questionnaire and its subscales would show medium associations to a single item assessing general positive effects of digital media use. Investigating the convergent construct validity for negative effects of digital media use we expect (b) medium to high positive associations between negative effects of digital media use with scales assessing general worse mental health (negative mental health), negative experiences with digital media (symptoms of problematic media use, cyberbullying experiences), and also medium associations with a single item assessing general negative effects of digital media use. Considering divergent construct validity of negative effects of digital media, we expect (c) that associations between these convergent scales of positive effects of digital media use and the negative effects of digital media use are negative and small, while (d) that associations between convergent scales of the negative effects of digital media use and the positive effects of digital media use are negative and small. In addition, we investigate associations between positive and negative effects and socio-demographic variables (age, gender), digital media use times, boredom, self-esteem, personality, and internet-use motives. The effects of digital media use should be widely independent from these constructs which is why we expect (e) small effect sizes for these associations.

2. Methods

2.1. Participants and procedure

Overall, 1921 individuals started the survey and 920 (47.9%) persons dropped out. Thus, the sample included 1001 participants from Germany (aged: $M = 17.57$, $SD = 0.71$, range 16–18, female 49.6%). Further details of the sample are presented in the [Supplementary Material Table S1](#). Data was collected in May and June 2023 by an independent social marketing and research institute (KANTAR, kantarc.com/de) via a population-based online panel survey. Participants were recruited from the residential population aged 16 to 18. Gender and region/federal state stratification were implemented to achieve representativeness. Participation was compensated by panel-specific tokens that can be converted into vouchers or monetary payments. There were no specific requirements for participation except being 16–18 years old. All participants were properly instructed and gave their informed consent to participate. At the beginning of the survey, the term 'digital media' was defined as any type of digital media use on any device, including activities such as using social media platforms like TikTok and Instagram or playing online games. The responsible ethics committee approved the current study's implementation (approval number: 866). It was pre-registered with [AsPredicted.org](https://www.aspredicted.org) on May 04, 2023 (#131075). All national regulations and laws regarding human subjects' research were followed. The study was conducted in accordance with the Declaration of Helsinki. All data sets used in the present study were complete.

2.2. Measures

2.2.1. Demographics

Participants were asked to indicate their age, gender, number of siblings, type of school, grade level, highest educational level, and occupation of their parents.

2.2.2. Digital media use effects-scales for adolescents (d-MUSE-scales)

We consider the perceived positive and negative effects of digital media use as two separate dimensions and thus developed two scales: 1) the positive digital Media Use Effects-Scale (d-MUSE-pos) and 2) the negative digital Media Use Effects-Scale (d-MUSE-neg). Each scale consists of six subscales representing areas of life relevant for well-being in children and adolescents (Ravens-Sieberer et al., 2005; The KIDSCREEN Group Europe, 2006). Specifically, we took on the four KIDSCREEN subscales "Physical Well-Being", "Mental Well-Being", "Peers & Social Support", and "School Environment" and split its fifth subscale "Autonomy & Relationship with Parents" into two subscales ("Autonomy" and "Relationship with Parents"). To account for adolescents' diverse preferences regarding devices (e.g., smartphones, tablets, laptops) and applications (e.g., social media, games, streaming platforms), we used the general term "digital media" in the instructions to provide a broad overview of the effects of digital media use in general.

The initial pool of items consisted of 80 items – 38 items on functional media use and 42 items on dysfunctional media use – were developed. The items focus on positive and negative effects of digital media use over the past week ("If you look at the **past week**, has your use of digital media contributed to the fact ..."), and were rated on a 5-point Likert-type scale (0 = *strongly disagree*, 4 = *strongly agree*). Four psychologists generated items for each of the six domains of life. Through (several) expert reviews by the psychologists, the appropriateness of context, conciseness, and wording of each item were evaluated. Inappropriate items were either revised or discarded as needed. The aim was to generate between five and ten items per domain of life and per subscale (d-MUSE-pos, d-MUSE-neg).

The set of items used in the validation of the d-MUSE-pos scale consists of seven items that belong to the "Physical Well-Being" subscale (e.g., that you felt fit and well?), seven items that belong to the "Mental Well-Being" subscale (e.g., that you enjoyed life?), seven items that belong to the "Autonomy" subscale (e.g., that you had time for yourself?), five items that belong to the "Relationship with Parents" subscale (e.g., that you got on well with your parents?), seven items that belong to the "Peers & Social Support" subscale (e.g., that you could spend time with your friends?), and five items that belong to the "School Environment" subscale (e.g., that you coped at school?).

The d-MUSE-neg scale consists of eight items that belong to the "Physical Well-Being" subscale (e.g., that you felt physically worn-out?), twelve items that belong to the "Mental Well-Being" subscale (e.g., that you felt sad?), six items that belong to the "Autonomy" subscale (e.g., that you felt constricted?), five items that belong to the "Relationship with Parents" subscale (e.g., that you had conflicts with your parents?), six items that belong to the "Peers & Social Support" subscale (e.g., that you were afraid of other children and young people?), and five items that belong to the "School Environment" subscale (e.g., that you were unhappy at school?). All items of the d-MUSE Scales in German and their English translations can be found in the supplementary material ([Tables S2 and S3](#)). To allow comparisons between subscales with varying numbers of items, mean scores were calculated with a higher mean score indicating more intense positive/negative effects. Following a simple economic approach, difference scores (d-MUSE-dif) describing the difference between positive and negative consequences as an indicator for the overall outlet of the engagement in the behavior were calculated. This was done for each area of life (e.g., d-MUSE-pos "Physical Well-Being" minus d-MUSE-neg "Physical Well-Being"). The d-MUSE-dif score represent how balanced positive and negative effects on well-being are and can be understood as an indicator for the degree of

functional digital media use in this specific domain, with positive scores indicating a higher degree of functional digital media use and negative scores indicating a higher degree of dysfunctional digital media use.

2.2.3. Media use time

Participants indicated by self-report how much time (in hours/day) they spent on gaming, general Internet use, video streaming, and social media on an average working day and on an average weekend day, respectively.

2.2.4. Boredom

The short Boredom Proneness Scale (BPS; original version: [Struk et al., 2017](#); German version: [Wegmann et al., 2018](#)) measured boredom by eight items (e.g., “It is not easy to entertain myself”). that were rated on a 7-point Likert-type scale (1 = *strongly disagree*, 7 = *strongly agree*). Higher sum scores indicate higher levels of boredom.

2.2.5. Self-esteem

We measured self-esteem with the German version of the Single-Item Self-Esteem Scale (SISE; German language version: [Brailovskaia & Margraf, 2020](#); original version: [Robins et al., 2001](#)). Participants rated how much the item “I have a high self-esteem” applied to them on a 5-point Likert-type scale (1 = *not very true of me*, 5 = *very true of me*). Higher ratings indicate higher self-esteem.

2.2.6. Personality

Personality was measured with the German version of the short version of the Big Five Inventory ([Rammstedt & John, 2007](#)). The 10 items (e.g., “I see myself as someone who is reserved”) focus on the past week and are divided into 5 subscales: “Extraversion”, “Agreeableness”, “Conscientiousness”, “Neuroticism”, and “Openness”. Items were answered on a 5-point Likert-type scale (1 = *disagree strongly*, 5 = *agree strongly*). Higher sum scores indicate higher levels of “Extraversion”, “Agreeableness”, “Conscientiousness”, “Neuroticism”, and “Openness”.

2.2.7. Internet use motives

The English version of the questionnaire of Internet use motives ([Rosell et al., 2022](#)) was translated and translated back into German and English. The 20 items (e.g., “I use the internet because it’s entertaining”) are divided into 5 subscales “Enhancement”, “Social”, “Coping”, “Conformity”, and “Utility” and were answered on a 5-point Likert-type scale (1 = *never*, 5 = *always*). Higher sum scores indicate more frequent internet use due to the specific motives.

2.2.8. Health-related quality of life

The KIDSCREEN-10 for Children and Young People (original and German language version: [The KIDSCREEN Group Europe, 2006](#)) assesses the health-related quality of life over the past week with ten items. The items were rated on a 5-point Likert-type scale (e.g., “Have you physically felt fit and well?”; 1 = *not at all*, 5 = *extremely*). Higher sum scores indicate a higher health-related quality of life.

2.2.9. Positive Mental Health (PMH)

We used the unidimensional Positive Mental Health Scale (PMH-Scale; original German language version: [Lukat et al., 2016](#)) to assess PMH. The PMH-Scale is a well-established instrument for the assessment of emotional, cognitive and psychological well-being. It includes nine items that were rated on a 4-point Likert-type scale (e.g., “I enjoy my life.”; 0 = *do not agree*, 3 = *agree*). The higher the sum score, the higher the level of PMH.

2.2.10. Life satisfaction

The unidimensional Satisfaction with Life Scale measured life satisfaction (SWLS; original version: [Diener et al., 1985](#); German version: [Glaesmer et al., 2011](#)). The five items were rated on a 7-point Likert-type scale (e.g., “In most ways, my life is close to my ideal.”; 1 = *strongly*

disagree, 7 = *strongly agree*). The higher the sum score, the higher the level of life satisfaction.

2.2.11. Sense of control

Following [Niemeyer et al. \(2019\)](#), we assessed sense of control with the two items “Do you experience important areas of your life (i.e., work, free time, family, etc.) to be uncontrollable, meaning that you cannot, or barely can, influence them?” and “Do you experience these important areas of your life as unpredictable or inscrutable?”. The two items were rated on a 5-point Likert-type scale (0 = *not at all*, 4 = *very strong*). We recoded both items. Thus, higher sum scores indicate lower levels of control.

2.2.12. Self-efficacy

The General Self-Efficacy Scale (GSE-Scale; original scale: [Schwarzer & Jerusalem, 1995](#)) assessed the general sense of perceived self-efficacy. The ten items were rated on a 4-point Likert-type scale (e.g., “I am confident that I could deal efficiently with unexpected events”; 1 = *not at all*, 4 = *exactly true*). Higher sum scores indicate higher self-efficacy.

2.2.13. Internet use competence

The Internet Literacy Questionnaire (ILQ; German language version: [Stodt, Brand, et al., 2018](#)) assessed Internet use competence on four dimensions: technical expertise, reflection and critical analysis, production and interaction, and self-regulation. The 18 items were rated on a 6-point Likert-type scale (0 = *strongly disagree*, 5 = *strongly agree*). Higher sum scores indicate higher Internet literacy.

2.2.14. Problematic digital media use

We assessed problematic media use with a modified version of the Gaming Disorder Scale for Adolescents (GADIS-A; original German version: [Paschke et al., 2020](#)). The terms “games” and “gaming” in the nine items of the GADIS-A were replaced by the term “digital media” (e.g., “I often use digital media more frequently and longer than I planned to or agreed upon with my parents”). The items were rated on a 5-point Likert-type scale (1 = *strongly disagree*, 5 = *strongly agree*). The higher the sum score, the higher the level of problematic digital media use.

2.2.15. Cyberbullying experiences

Based on the Cyberbullying questionnaire ([Stodt, Wegmann, & Brand, 2018](#)), two items were selected asking for experiences on cyberbullying in the role of a passive perpetrator (“In the last six months, I made a hurtful or embarrassing statement about another person on the internet by liking or sharing.”) and victim (“In the last six months, I was cyberbullied online.”). Participants were asked to rate the frequency of their experiences during the past six months on a 5-point Likert-type scale (1 = *never*, 5 = *very often*). Higher scores indicate higher levels of cyberbullying experience.

2.2.16. Negative mental health

We assessed negative mental health with the Brief Symptom Inventory (BSI; original version: [Derogatis & Spencer, 1993](#); German language version: [Franke & Derogatis, 2000](#)). The 53 items (e.g., “nervousness and inner tremor”) focus on the past week and are divided into nine subscales “somatic symptoms”, “obsessiveness”, “social insecurity”, “depressiveness”, “general anxiety”, “aggressiveness”, “specific phobia”, “paranoia”, and “psychoticism”, and four single items that assess bad appetite, sleep problems, suicide ideation, and feelings of guilt. The items were rated on a 5-point Likert-type scale (0 = *not at all*, 4 = *extremely*). The higher the sum score of the subscales or the higher the score of the four single items, the higher the level of negative mental health.

2.2.17. General effects of media use

We formulated two items to assess to which degree one’s digital media use contributes to one’s well-being (“Overall, my use of digital

media contributes to making me feel good.”), and to which degree it harms one’s well-being (“Overall, my use of digital media contributes to making me feel bad.”). The items were rated on a 5-point Likert-type scale (0 = *not at all*, 4 = *very strong*).

Table 4 shows the internal consistency of the used scales.

2.3. Statistical analyses

Statistical analyses were conducted using SPSS 28 (IBM Corp, 2021) and MPlus (Muthén & Muthén, 2011). All investigated psychological variables were close to normally distributed (indicated by analyses of skewness, <3.00, and kurtosis, <8.00; see Table 4). We investigated the psychometric properties of the d-MUSE Scales. Considering that the items of both main scales were developed based on the six-subscale structure, we first calculated two separate confirmatory factor analyses (CFA, conducted with MPlus) to test the assumed 6-factor structure of the d-MUSE-pos scale and of the d-MUSE-neg scale (model 1a and 1b, for schematic representation see Fig. 1A). In order to test whether the scales function similarly across female and male adolescents, we tested for measurement invariance across gender (see Supplementary Material Table S9).

In the next step, we assessed their scale properties by the calculation of internal consistency (Cronbach’s α), mean interitem correlation (r_{mi}), item-total scale correlation (r_{it}), and item difficulty (p_m). Notably, the CFA and the scale properties analyses for the d-MUSE-pos scale revealed that no items should be deleted to improve the properties. In contrast, four items of the d-MUSE-neg scale were deleted because of CFA factor loads and very low item difficulty (see details in results section).

In addition, 2 s-order models were estimated with dMUSE-pos and d-MUSE-neg modeled as correlated second order factors in model 2, and the six areas of life modeled as correlated second order factors in model 3. See Fig. 1 B-D for a more schematic representation of the models. The second-order models were compared to a first-order model including all 12 subscales (model 4) with a χ^2 difference test.

To investigate the construct validity of both scales, we calculated their associations with age, gender, daily time spent on gaming, general Internet use, video streaming, and social media use on working days and on weekends, problematic media use, boredom, cyberbullying experiences, negative mental health symptoms (somatic symptoms, obsessiveness, social insecurity, depressiveness, general anxiety, aggressiveness, specific phobia, paranoia, psychoticism, bad appetite, sleep problems, suicide ideation, and feelings of guilt), as well as health related quality of life, PMH, life satisfaction, sense of control, self-esteem, self-efficacy and internet use competence by the calculation of Pearson’s zero-order bivariate correlations and point-biserial correlations. In addition, correlations were estimated with the two single items assessing general effects of digital media use.

3. Results

3.1. Factor structure of the d-MUSE Scales: confirmatory factor analyses (CFA)

Based on our assumption that the d-MUSE Scales are two independent scales we first checked the 6-factor structure for each of the scales separately. The CFA that included the 38 items of the d-MUSE-pos in a 6-factor structure resulted in a significant chi-square value, $\chi^2 = 1982.0$, degrees of freedom (df) = 650, $p < .001$. Because of the sample size sensitivity of the χ^2 test (Oishi, 2007), we took further fit indices into consideration (Schermelleh-Engel et al., 2003): The comparative fit index (CFI) reached a value of .930, the root mean square error of approximation (RMSEA) was .045 (90% CI [.043, .048]), and the standardized root mean residual (SRMR) was .039, all indicated a good fit (Bentler, 1990; Homburg & Baumgartner, 1995; Hooper et al., 2008; Shi et al., 2019). Table 2 shows the standardized factor loads of the 38 items sorted by factor (subscale). The loads ranged between .550 (item 15)

and .780 (item 8).

The CFA that included the 42 items of the d-MUSE-neg confirmed the hypothesized 6-factor structure ($\chi^2 = 1974.0$, $df = 804$, $p < .001$; CFI = .949, RMSEA = .038 (90% CI [.036, .040]), SRMR = .036). The standardized factor loads ranged between .338 (item 39) and .776 (item 67). We deleted items 39, 40 and 41 whose factor loads were below .500. In addition, we deleted item 72 whose item difficulty was $p_m = 13.0\%$. This resulted in a 38-item d-MUSE-neg scale with a 6-factor structure and an even better model fit ($\chi^2 = 1552.0$, $df = 650$, $p < .001$; CFI = .958, RMSEA = .037 (90% CI [.035, .040]), SRMR = .034). The standardized factor loads of the 38 items ranged between .531 (item 43) and .776 (item 67) (see Table 3).

Additionally, we tested for measurement invariance across gender. Model fits and further details are presented in Table S9 (supplementary material). For both scales configural and metric measurement invariance could be established. Partial scalar invariance could be established for the d-MUSE-neg scale but not for the d-MUSE-pos scale.

Thus, the 6-factor model fits the data well for the two d-MUSE Scales with 38 items each. We additionally tested one-factor structures for each of the two d-MUSE Scales. Model fits for the d-MUSE-pos scale were: $\chi^2 = 4358$, $df = 665$, $p < .001$; CFI = .805, RMSEA = .075 (90% CI [.072, .077]), SRMR = .058. The standardized factor loads ranged between .519 (item 15) and .719 (item 9). Model fits for the d-MUSE-neg scale were: $\chi^2 = 3533$, $df = 665$, $p < .001$; CFI = .867, RMSEA = .066 (90% CI [.064, .068]), SRMR = .054. The standardized factor loads ranged between .482 (item 43) and .742 (item 61). In contrast with the 6-factor models, model fits of both one-factor models were not satisfactory.

In the second-order models, subscales (e.g., “Positive Mental Well-Being”) were again modeled latently on item level. Model fits for the d-MUSE-pos, d-MUSE-neg second order model (model 2 “d-MUSE-pos and d-MUSE-neg”) were: $\chi^2 = 5284.07$, $df = 2,761$, $p < .001$; scaling correction factor for MLR = 1.209; CFI = .924; RMSEA = .030, 90% CI [.029, .031]; SRMR = .052. To test whether positive and negative subscales for one area of life fit on one factor (e.g., “Mental Well-Being” of the positive and “Mental Well-Being” of the negative subscales on one “Mental Well-Being” second order subscale, model 3 “areas of life”), we tested another second-order CFA. Model fits for these subscales second-order model were: $\chi^2 = 7964.50$, $df = 2,747$, $p < .001$; scaling correction factor for MLR = 1.206; CFI = .843; RMSEA = .044, 90% CI [.042, .045]; SRMR = .171. In addition, we tested a first-order model with 12 factors (6 factors for d-MUSE-pos and 6 factors for d-MUSE-neg, model 4 “baseline”). This model was used as baseline model to compare model fits of the second-order models. Model fits for this baseline model were: $\chi^2 = 4479.3$, $df = 2,708$, $p < .001$; scaling correction factor for MLR = 1.209; CFI = .947; RMSEA = .026, 90% CI [.024, .027]; SRMR = .038. Using χ^2 difference testing, both models showed significantly worse model fits compared to the baseline model ($ts \geq 804.7$, $p \leq .001$). The second-order d-MUSE-pos and d-MUSE-neg model performed better compared to the second-order subscales model ($t(14) = 2330.67$, $p \leq .001$). Accordingly, modelling each subscale without higher order factors showed the best model fit. Nevertheless, also the model fits for the second-order d-MUSE-pos and d-MUSE-neg model were acceptable which justifies the use of an overall d-MUSE-pos and overall d-MUSE-neg based on the mean-scores of the subscales. The model fits for the second-order subscales model were not satisfactory.

3.2. Scale properties of the d-MUSE Scales

Tables 2 and 3 show the descriptive statistics and the properties of the d-MUSE Scales with 38 items each, and their respective six subscales. The internal consistency of the six subscales of the d-MUSE-pos was good, ranging between $\alpha = .818$ (“Autonomy” subscale) and $\alpha = .873$ (“Physical Well-Being” subscale) (see Table 2); the internal consistency of the six subscales of the d-MUSE-neg was acceptable to excellent, ranging between $\alpha = .771$ (“Physical Well-Being” subscale) and $\alpha = .927$ (“Mental Well-Being” subscale) (see Table 3); for all subscales, deletion

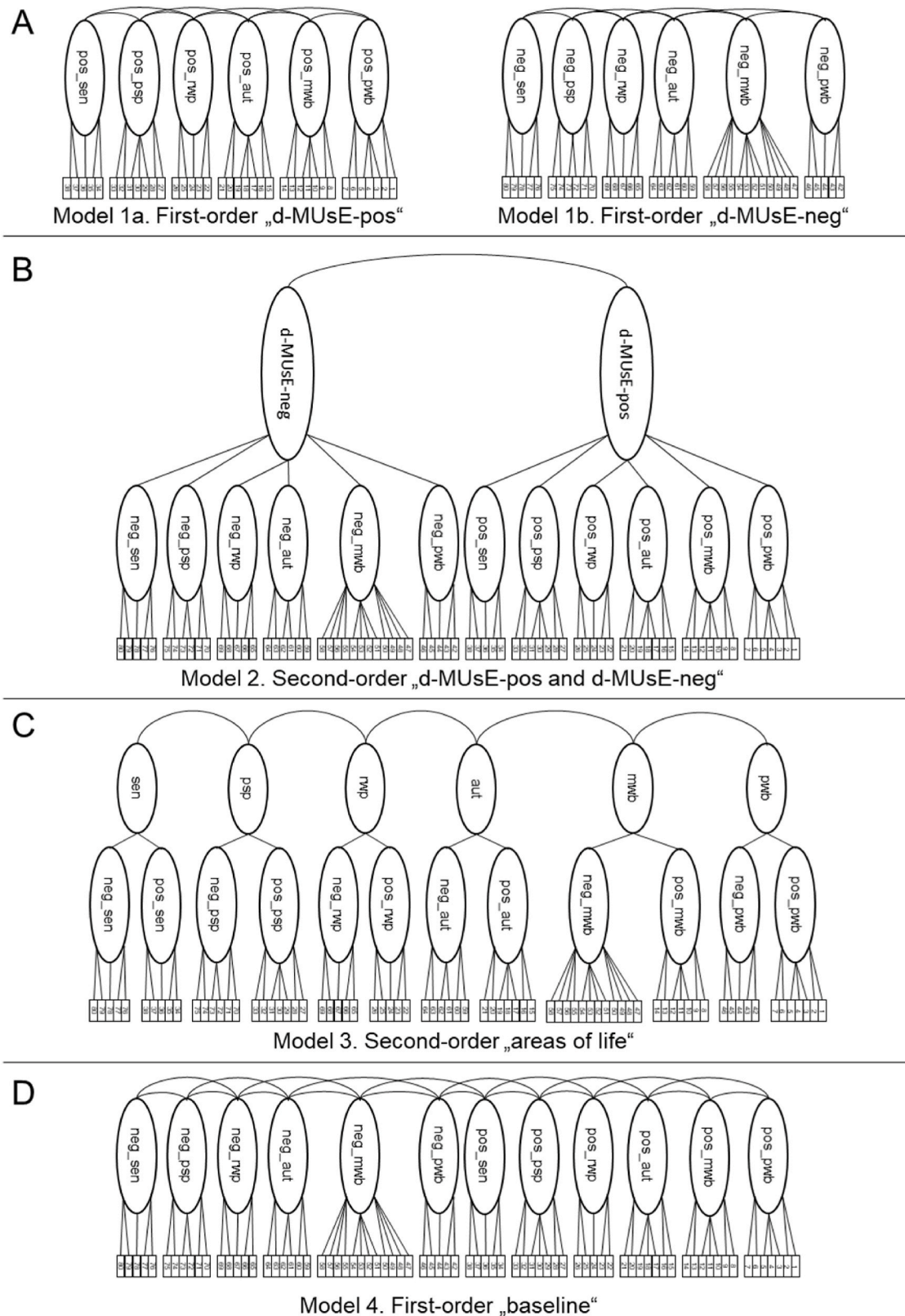


Fig. 1. Schematic representation of first-order and second-order factor analyses applied for the d-MUSE-items. All factors at highest order were correlated with each other. For illustrational purposes not all bogues representing correlations are presented. Part A shows the two first-order models for the “d-MUSE-pos” and “d-MUSE-neg” scales. Part B shows the second-order d-MUSE-pos and d-MUSE-neg”, part C model three with the second-order model where “areas of life” are modeled at second level and part d shows the first-order “baseline” model with all factors (positive and negative) included. Aut = autonomy; d-MUSE-pos = Positive Digital Media Use Effects Scale; d-MUSE-neg = Negative Digital Media Use Effects Scale; mwb = mental well-being; neg = negative; psp = peers and social support; phw = physical well-being; pos = positive; rwp = relationship with parents; sen = school environment.

Table 2
Psychometric properties of the final six subscales of the positive digital media use effects scale (d-MUSE-pos).

	<i>M</i> (<i>SD</i>)	CFA Factor Loads	α	α without item	r_{mi}	r_{it}	p_m
“Physical Well-Being” subscale	2.00 (.94)	Factor 1	.873		.496		
Item 1	2.03 (1.21)	.738		.857		.662	34.3
Item 2	2.00 (1.22)	.743		.853		.669	33.3
Item 3	1.95 (1.33)	.716		.850		.689	31.7
Item 4	1.97 (1.23)	.673		.863		.590	32.3
Item 5	2.00 (1.31)	.702		.853		.670	33.3
Item 6	1.97 (1.20)	.651		.860		.610	32.3
Item 7	2.07 (1.22)	.708		.852		.672	35.7
“Mental Well-Being” subscale	2.25 (.92)	Factor 2	.872		.491		
Item 8	2.29 (1.22)	.780		.844		.723	43.0
Item 9	2.18 (1.26)	.776		.845		.713	39.3
Item 10	2.49 (1.13)	.600		.866		.549	49.7
Item 11	2.73 (1.10)	.609		.865		.554	57.7
Item 12	2.07 (1.31)	.750		.846		.703	35.7
Item 13	2.02 (1.31)	.719		.850		.673	34.0
Item 14	1.92 (1.30)	.686		.857		.628	30.7
“Autonomy” subscale	2.30 (.84)	Factor 3	.818		.392		
Item 15	2.43 (1.21)	.671		.801		.515	47.7
Item 16	2.44 (1.19)	.648		.795		.553	48.0
Item 17	2.18 (1.19)	.652		.783		.625	39.3
Item 18	2.27 (1.26)	.681		.795		.552	42.3
Item 19	2.16 (1.24)	.597		.790		.581	38.7
Item 20	2.17 (1.21)	.550		.793		.565	39.0
Item 21	2.41 (1.23)	.573		.801		.518	47.0
“Relationship with Parents” subscale	2.27 (.96)	Factor 4	.834		.501		
Item 22	2.21 (1.24)	.734		.793		.662	40.3
Item 23	2.18 (1.26)	.751		.794		.658	39.3
Item 24	2.40 (1.21)	.681		.806		.617	46.7
Item 25	2.43 (1.21)	.627		.817		.577	47.7
Item 26	2.15 (1.27)	.747		.795		.657	38.3
“Peers & Social Support” subscale	2.38 (.91)	Factor 5	.872		.494		
Item 27	2.35 (1.22)	.760		.847		.705	45.0
Item 28	2.26 (1.23)	.662		.861		.602	42.0
Item 29	2.48 (1.21)	.732		.851		.675	49.3
Item 30	2.42 (1.18)	.709		.851		.674	47.3
Item 31	2.47 (1.22)	.679		.857		.629	49.0
Item 32	2.40 (1.24)	.730		.850		.681	46.7
Item 33	2.26 (1.20)	.660		.863		.585	42.0
“School Environment” subscale	1.93 (1.00)	Factor 6	.827		.489		
Item 34	2.14 (1.25)	.702		.798		.606	38.0
Item 35	1.89 (1.29)	.670		.802		.593	29.7
Item 36	1.90 (1.32)	.725		.786		.648	30.0
Item 37	1.84 (1.32)	.703		.792		.626	28.0
Item 38	1.89 (1.30)	.700		.787		.643	29.7

Notes. $N = 1001$; Final factor structure after omitting items. $M =$ Mean, $SD =$ Standard Deviation, CFA Factor Loads = loading of the items in the confirmatory factor analysis, standardized estimates; internal consistency: $\alpha =$ Cronbach’s α ; $r_{mi} =$ mean interitem correlation; $r_{it} =$ item-total scale correlation; $p_m =$ item difficulty in %.

of any item would not improve the internal consistency (see Tables 2 and 3). The mean interitem correlation of the d-MUSE-pos ($r_{mi} = .381$), the d-MUSE-neg ($r_{mi} = .435$), and their subscales (see Tables 2 and 3) was acceptable to good. The item-total scale correlation of the items of the d-MUSE-pos scale and of the items of the d-MUSE-neg scale was good (see Tables 2 and 3). The item difficulty of the items of the d-MUSE-pos scale was acceptable to good (see Table 2); the item difficulty of most items of the d-MUSE-neg scale was acceptable. Several items of the d-MUSE-neg scale, especially those that belonged to the “Peers & Social Support” subscale, had a low item difficulty (see Table 3). However, their other properties were good. Therefore, we decided not to delete them from the scale. Overall, the findings reveal acceptable scale properties of the d-MUSE Scales.

Due to the good model fits of the second-order d-MUSE-pos and d-MUSE-neg model, we also estimated overall mean scores for d-MUSE-pos and d-MUSE-neg across the respective six subscale means. The means, standard deviations, min-max, and internal consistency for the overall mean scores were $M = 2.19$, $SD = 0.78$, min-max: 0–4, $\alpha = .916$ for the d-MUSE-pos overall mean score and $M = 1.79$, $SD = 0.89$, min-max: 0–4, $\alpha = .939$ for the d-MUSE-neg overall mean score, indicating good scale properties.

Fig. 2 shows sample means and standard deviations of the d-MUSE

Scales in combination with the d-MUSE-dif score for each subscale. Mean d-MUSE-dif scores were all positive indicating more positive than negative effects of digital media use on all subscales. The d-MUSE-dif score assessing the degree of functional digital media use were highest for the “Peers and Social Support” subscale and lowest for “Physical Well-Being” and “School Environment”. Results of paired-sample t-tests testing for domain differences can be found in Table S4 of the supplementary material. Histograms of the d-MUSE-pos, d-MUSE-neg and d-MUSE-dif scores are presented in the supplementary material (Fig. S1).

3.3. Construct validity of the d-MUSE Scales

Table 4 shows the descriptive statistics for all measures used to investigate the construct validity.

3.3.1. Correlations between d-MUSE-pos, d-MUSE-neg, and d-MUSE-dif scores

Table 5 displays the between-scale correlations. Overall, correlations between the d-MUSE-pos and d-MUSE-neg scales in one area of life were small, ranging between .012 (“Peers & Social Support”) and $-.126$ (“Mental Well-Being”). Scatterplots displaying associations between d-MUSE-pos and d-MUSE-neg scales are presented in the supplementary

Table 3
Psychometric properties of the final six subscales of the negative digital media use effects scale (d-MUsE-neg).

	<i>M</i> (<i>SD</i>)	CFA Factor Loads	α	α without item	r_{mi}	r_{it}	p_m
“Physical Well-Being” subscale	1.89 (.95)	Factor 1	.771		.403		
Item 42	1.68 (1.35)	.671		.720		.568	22.7
Item 43	2.25 (1.32)	.531		.762		.444	41.7
Item 44	1.83 (1.33)	.630		.725		.552	27.7
Item 45	1.89 (1.26)	.663		.721		.567	29.7
Item 46	1.78 (1.29)	.688		.715		.582	26.0
“Mental Well-Being” subscale	1.97 (.97)	Factor 2	.927		.513		
Item 47	2.01 (1.31)	.748		.919		.717	33.7
Item 48	1.98 (1.27)	.725		.920		.700	32.7
Item 49	1.93 (1.35)	.735		.920		.701	31.0
Item 50	1.99 (1.35)	.748		.920		.715	33.0
Item 51	1.98 (1.34)	.714		.921		.687	32.7
Item 52	2.04 (1.28)	.706		.921		.677	34.7
Item 53	2.07 (1.30)	.733		.920		.714	35.7
Item 54	1.95 (1.30)	.650		.923		.621	31.7
Item 55	2.01 (1.31)	.683		.922		.657	33.7
Item 56	1.74 (1.28)	.728		.921		.688	24.7
Item 57	2.00 (1.31)	.677		.922		.653	33.3
Item 58	1.92 (1.30)	.753		.919		.722	30.7
“Autonomy” subscale	1.78 (1.02)	Factor 3	.861		.507		
Item 59	1.82 (1.29)	.642		.850		.580	27.3
Item 60	1.92 (1.33)	.659		.849		.591	30.7
Item 61	1.71 (1.33)	.765		.828		.705	23.7
Item 62	1.73 (1.35)	.729		.834		.675	24.3
Item 63	1.74 (1.35)	.732		.834		.675	24.7
Item 64	1.78 (1.34)	.761		.831		.690	26.0
“Relationship with Parents” subscale	1.72 (1.05)	Factor 4	.851		.532		
Item 65	1.65 (1.32)	.710		.826		.637	21.7
Item 66	1.78 (1.32)	.692		.832		.614	26.0
Item 67	1.65 (1.33)	.776		.806		.712	21.7
Item 68	1.82 (1.34)	.714		.823		.651	27.3
Item 69	1.71 (1.35)	.763		.812		.691	23.7
“Peers & Social Support” subscale	1.58 (1.06)	Factor 5	.849		.530		
Item 70	1.50 (1.35)	.719		.815		.672	16.7
Item 71	1.44 (1.35)	.686		.823		.644	14.7
Item 73	1.68 (1.33)	.736		.817		.666	22.7
Item 74	1.59 (1.31)	.735		.816		.669	19.7
Item 75	1.69 (1.34)	.757		.823		.643	23.0
“School Environment” subscale	1.82 (1.06)	Factor 6	.840		.513		
Item 76	1.75 (1.38)	.751		.807		.645	25.0
Item 77	1.81 (1.34)	.747		.803		.659	27.0
Item 78	1.80 (1.33)	.705		.803		.662	26.7
Item 79	1.88 (1.36)	.684		.814		.622	29.3
Item 80	1.87 (1.39)	.685		.811		.630	29.0

Notes. *N* = 1001; Final factor structure after omitting items. *M* = Mean, *SD* = Standard Deviation, CFA Factor Loads = loading of the items in the confirmatory factor analysis, standardized estimates; internal consistency: α = Cronbach’s α ; r_{mi} = mean interitem correlation; r_{it} = item-total scale correlation; p_m = item difficulty in %.

material (Fig. S2). Correlations of the d-MUsE-pos and d-MUsE-neg scales with the d-MUsE-dif scores were high, ranging between .650 (“Peers & Social Support”) and .735 (“Mental Well-Being”) for the d-MUsE-pos scales and between $-.672$ (“Physical Well-Being”) and $-.787$ (“Autonomy”) for the d-MUsE-neg scales.

3.3.2. Divergent validity

There were only small correlations between the d-MUsE Scales and age as well as gender (Table 6). The d-MUsE-neg scales showed slightly higher effect sizes for the correlations with age compared to the d-MUsE-pos scales. The d-MUsE-pos scales showed slightly higher effect sizes for correlations with gender compared to the d-MUsE-neg scales, indicating more positive effects of digital media use for boys than for girls.

Effect sizes for correlations between the d-MUsE Scales and media use times were very small, ranging between .004 and .121 for daily use time on working days and between .008 and .133 for daily use time on weekend days. Boredom proneness was significantly negatively associated with all d-MUsE-pos scales with small effect sizes (range: .242 to $-.121$) while the d-MUsE-neg (range: .386 to .502, all positive) and d-MUsE-dif scores (range: .385 to $-.496$, all negative) showed medium to high effect sizes. Self-esteem was positively associated with d-MUsE-pos (range: .160 to .270) and d-MUsE-dif score (range: .124 to .261) with

small effect sizes, and non-significantly or only with very low effect sizes associated with the d-MUsE-neg (range: .024 to $-.125$) scores. While correlations with personality all had small effect sizes, some positive correlations with medium effect sizes could be identified between use motives and d-MUsE-neg scales: d-MUsE-neg “Autonomy” and conformity and social motives, d-MUsE-neg “Relationship With Parents” and conformity motives, as well as d-MUsE-neg “Peers & Social Support” and conformity and social motives. Overall, the correlations support our argument that positive and negative effects are different from use times, self-esteem, personality traits and most Internet use motives. The medium to high correlations with boredom proneness were not expected.

3.3.3. Convergent validity

Table 7 shows correlations between the d-MUsE Scales and expected convergent measures. The d-MUsE-pos scales were significantly positively correlated with health-related quality of life, positive mental health, life satisfaction, self-efficacy, internet use competence, and general impact of functional media use with medium to high effect sizes; the d-MUsE-neg scales were significantly positively correlated with problematic media use, cyberbullying experiences, somatic symptoms, obsessiveness, social insecurity, depressiveness, general anxiety, aggressiveness, specific phobia, paranoia, psychoticism, bad appetite,

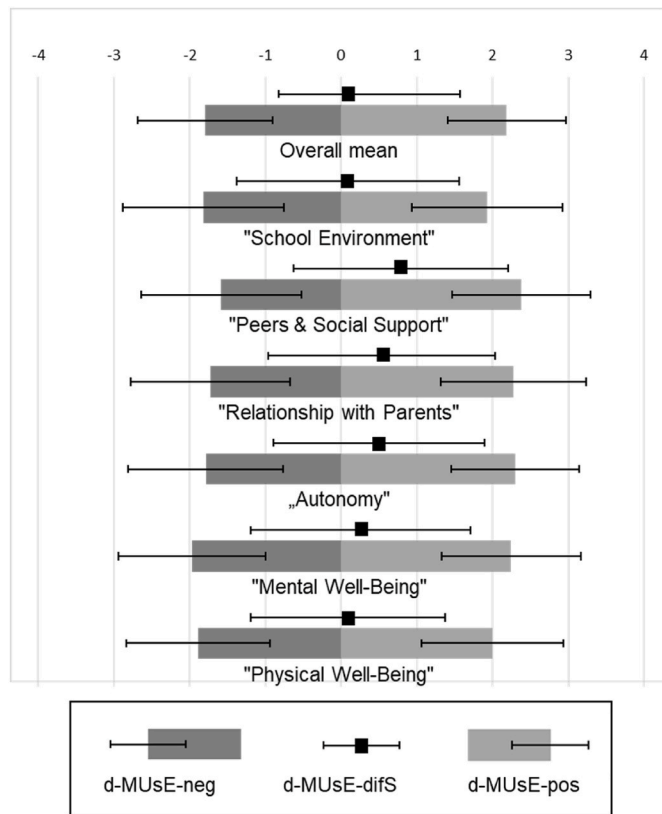


Fig. 2. Sample mean values and standard deviations for the d-MUSE-pos and d-MUSE-neg scores presented as bars with error bars. The mean d-MUSE-dif scores are displayed as squares with error bars. For illustrational purposes in this diagram, the d-MUSE-neg scale has been recoded from 0 = *strongly disagree*, -4 = *strongly agree*. d-MUSE-dif = Positive Digital Media Use Effects Scale Difference Score; d-MUSE-pos = Positive Digital Media Use Effects Scale; d-MUSE-neg = Negative Digital Media Use Effects Scale.

sleep problems, suicide ideation, feelings of guilt, and general negative effects of digital media use.

The d-MUSE-dif score was significantly positively correlated with health-related quality of life and positive mental health and negatively correlated with problematic media use and psychopathological symptoms, all showing medium to high effect sizes.

Thus, the findings revealed a good convergent validity of the d-MUSE-pos and d-MUSE-neg scales as well as the d-MUSE-dif score. The d-MUSE-pos and d-MUSE-neg scales showed a mostly show opposite result patterns (see Table 7).

3.4. Factor structure of short d-MUSE Scales

As the scale is intended for use with both children and adolescents, it is important to consider a shortened version, as attention spans may be shorter in younger individuals. In addition, a shortened version would be beneficial for longitudinal approaches. Since no statistical indicators supported reducing the number of items, two psychological experts identified three items per factor that most strongly represent each factor. CFAs were conducted, including individual first-order models for the “d-MUSE-pos” and “d-MUSE-neg” scales (model 1a and 1b, see Fig. 1A) and a second-order model incorporating both d-MUSE-pos and d-MUSE-neg (model 2, see Fig. 1B).

Model fit indices for the first-order models indicated good fit for both scales and were comparable to the long versions of the scales: d-MUSE-pos scale: $\chi^2 = 254.3$, $df = 120$, $p < .001$; CFI = .976, RMSEA = .033 (90% CI [.028, .039]), SRMR = .029, and d-MUSE-neg: $\chi^2 = 246.3$, $df = 120$, $p < .001$; CFI = .979, RMSEA = .032 (90% CI [.027, .038]), SRMR

Table 4
Descriptive statistics and properties of the investigated variables.

	M (SD)	Min-Max	Skew	Kurt	α^1
<i>Daily Use Time Working Day (hours/day)</i>					
Gaming	2.59 (2.99)	0–19	1.961	4.704	
Internet	4.20 (3.49)	0–19	1.492	2.356	
Video Streaming	2.79 (3.02)	0–19	1.782	3.925	
Social Media	4.46 (3.41)	0–20	1.258	1.407	
<i>Daily Use Time Weekend (hours/day)</i>					
Gaming	2.84 (1.93)	0–20	1.934	5.067	
Internet	3.94 (3.74)	0–23	2.211	5.951	
Video Streaming	3.39 (3.47)	0–23	1.997	5.564	
Social Media	4.58 (3.85)	0–23	1.909	4.620	
Problematic Media Use	23.47 (7.24)	9–45	.118	-.103	.817
Boredom Proneness	30.44 (9.95)	8–56	-.206	-.182	.857
Self-Esteem	3.13 (1.25)	1–5	-.138	-.933	
<i>Personality</i>					
Agreeableness	6.90 (1.82)	2–10	-.385	-.081	
Conscientiousness	5.97 (1.62)	2–10	-.091	.115	
Neuroticism	6.21 (1.70)	2–10	.044	-.145	
Openness	6.38 (1.80)	2–10	.048	-.152	
Extraversion	5.924 (1.82)	2–10	-.119	-.152	
<i>Motives</i>					
Enhancement	13.48 (3.64)	4–20	-.372	-.118	.752
Coping	12.11 (3.56)	4–20	-.207	-.118	.734
Conformity	10.79 (3.71)	4–20	.057	-.443	.718
Social	11.11 (3.96)	4–20	-.041	-.592	.785
Utility	12.09 (3.47)	4–20	-.183	-.196	.707
Health Related Quality of Life	35.33 (7.52)	15–55	.031	-.256	.773
Positive Mental Health	15.80 (6.36)	0–27	-.353	-.148	.893
Life Satisfaction	20.20 (5.97)	5–35	-.105	.153	.792
Sense of Control	4.60 (1.84)	0–8	-.009	-.274	.556
Self-Efficacy	25.77 (6.03)	10–40	-.160	.410	.858
Internet Use	46.84 (13.38)	0–90	-.266	1.294	.869
<i>Competence</i>					
General Impact of Functional Media Use	1.77 (1.04)	0–4	.114	-.388	
<i>Negative Mental Health</i>					
Somatic Symptoms	9.35 (6.85)	0–28	.283	-.899	.874
Obsessiveness	9.66 (5.94)	0–24	.150	-.679	.843
Social Insecurity	6.11 (4.25)	0–16	.224	-.787	.817
Depressiveness	8.75 (6.22)	0–24	.198	-.883	.871
General Anxiety	8.29 (5.70)	0–24	.355	-.575	.830
Aggressiveness	7.36 (5.06)	0–20	.287	-.745	.818
Specific Phobia	6.75 (5.22)	0–20	.400	-.798	.845
Paranoia	7.73 (4.81)	0–20	.135	-.721	.789
Psychoticism	7.15 (4.92)	0–20	.217	-.831	.794
Bad Appetite	1.43 (1.32)	0–4	.431	-1.061	
Sleep Problems	1.70 (1.40)	0–4	.230	-1.222	
Suicide Ideation	1.40 (1.40)	0–4	.543	-1.016	
Guilt Feelings	1.49 (1.35)	0–4	.454	-.997	
Cyberbullying	2.02 (1.30)	1–5	1.001	-.276	
<i>Experiences</i>					
Passive Perpetrator	1.98 (1.10)	1–5	.912	.000	
Victim	2.02 (1.30)	1–5	1.001	-.276	
General Impact of Dysfunctional Media Use	1.51 (1.14)	0–4	.403	-.580	

Notes. N = 1001; M = Mean; SD = Standard Deviation; Min = Minimum; Max = Maximum; Skew = Skewness; Kurt = Kurtosis; internal consistency: α = Cronbach's; d-MUSE-pos = Positive Digital Media Use Effects Scale; d-MUSE-neg = Negative Digital Media Use Effects Scale. ¹ Cronbach's alpha was calculated for scales with three items or more.

= .028. Model fits for the second-order model were also good and comparable to the long version, $\chi^2 = 1286.8$, $df = 181$, $p < .001$; CFI = .944, RMSEA = .035 (90% CI [.032, .037]), SRMR = .045. Psychometric properties are summarized in the Supplementary Material Tables S5 and S6. Correlations with convergent and divergent measures are comparable to those observed for the long version of the scale (see Supplementary Material, Tables S7 and S8).

Table 5
Correlations between d-MUSE-pos- d-MUSE-neg, and d-MUSE-dif scores.

	Overall Mean-Score			"Physical Well-Being"			"Mental Well-Being"			"Autonomy"			"Relationship with Parents"			"Peers & Social Support"			"School Environment"		
	pos	neg	dif	pos	neg	dif	pos	neg	dif	pos	neg	dif	pos	neg	dif	pos	neg	dif	pos	neg	dif
<i>Overall Mean-Score</i>																					
pos																					
neg	.016																				
dif	.652**	-.748**																			
<i>"Physical Well-Being"</i>																					
pos	.846**	.038	.533**																		
neg	.119**	.819**	-.543**	.104**																	
dif	.540**	-.586**	.803**	.667**	-.672**																
<i>"Mental Well-Being"</i>																					
pos	.851**	-.090**	.633**	.731**	.014	.533**															
neg	-.020	.864**	-.668**	-.005	.787**	-.594**	-.126**														
dif	.565**	-.649**	.867**	.477**	-.529**	.752**	.735**	-.766**													
<i>"Autonomy"</i>																					
pos	.875**	-.036	.608**	.697**	.075*	.462**	.793**	-.052	.549**												
neg	-.007	.926**	-.707**	.019	.698**	-.509**	-.107**	.805**	-.620**	-.062*											
dif	.545**	-.715**	.905**	.416**	-.477**	.667**	.570**	-.635**	.804**	.664**	-.787**										
<i>"Relationship with Parents"</i>																					
pos	.835**	-.005	.559**	.609**	.079*	.394**	.622**	-.032	.425**	.652**	-.023	.419**									
neg	-.020	.891**	-.689**	.013	.618**	-.454**	-.099**	.674**	-.525**	-.053	.791**	-.626**	-.070*								
dif	.558**	-.640**	.856**	.387**	-.390**	.581**	.476**	-.503**	.652**	.463**	-.580**	.721**	.701**	-.760**							
<i>"Peers & Social Support"</i>																					
pos	.840**	.034	.532**	.594**	.125**	.348**	.617**	.026	.382**	.732**	.010	.445**	.691**	.006	.445**						
neg	.066*	.868**	-.615**	.095**	.612**	-.388**	-.033	.623**	-.448**	-.006	.787**	-.594**	.067*	.774**	-.510**	.012					
dif	.503**	-.638**	.818**	.319**	-.383**	.525**	.432**	-.456**	.592**	.487**	-.592**	.744**	.404**	-.584**	.681**	.650**	-.753**				
<i>"School Environment"</i>																					
pos	.803**	.128**	.436**	.638**	.194**	.330**	.553**	.079*	.304**	.578**	.115**	.271**	.631**	.094**	.344**	.619**	.182**	.269**			
neg	-.046	.883**	-.700**	-.023	.626**	-.486**	-.114**	.674**	-.535**	-.081*	.776**	-.631**	-.044	.799**	-.600**	.008	.742**	-.559**	.017		
dif	.588**	-.561**	.816**	.457**	-.326**	.585**	.465**	-.441**	.603**	.459**	-.491**	.651**	.468**	-.523**	.678**	.421**	-.420**	.597**	.678**	-.723**	

Notes. pos = Positive Digital Media Use Effects Scale; neg = Negative Digital Media Use Effects Scale; net = Positive Digital Media Use Effects Scale Net-Score; * $p < .05$; ** $p < .001$.

Table 6
Correlations of the Digital Media Use Effects Scales (d-MUe Scales) with divergent measures.

	Overall Mean-Score			"Physical Well-Being"			"Mental Well-Being"			"Autonomy"			"Relationship with Parents"			"Peers & Social Support"			"School Environment"		
	pos	neg	dif	pos	neg	dif	pos	neg	dif	pos	neg	dif	pos	neg	dif	pos	neg	dif	pos	neg	dif
Age	.045	.143**	-.079*	.060	.093**	-.025	.028	.102**	-.052	.036	.129**	-.074*	.037	.147**	-.081*	.044	.154**	-.088**	.021	.121**	-.074*
Gender	-.187**	-.009	-.118**	-.219**	-.006	-.158**	-.207**	.077*	-.187**	-.161**	-.008	-.093**	-.129**	-.026	-.066*	-.104**	-.069*	-.016	-.126**	-.008	-.082**
<i>Daily Use Time Working Days (hours/day) rowhead</i>																					
Gaming	.093**	.106**	-.019	.081*	.090**	-.007	.064*	.053	.006	.099**	.108**	-.020	.089**	.088**	-.005	.084**	.121**	-.037	.056	.096**	-.031
Internet	.070*	.063*	-.001	.054	.067*	-.010	.065*	.043	.013	.069*	.064*	-.006	.072*	.036	.021	.054	.065*	-.014	.044	.059	-.013
Video Streaming	.013	.107**	-.072*	-.017	.078*	-.071*	.007	.083**	-.052	.028	.117**	-.070*	.004	.094**	-.065*	.015	.096**	-.063*	.031	.090**	-.045
Social Media	.044	.104**	-.050	.026	.081*	-.041	.008	.079*	-.048	.066*	.101**	-.035	.052	.074*	-.019	.036	.097**	-.050	.038	.115**	-.059
<i>Daily Use Time Weekend (hours/day) rowhead</i>																					
Gaming	.105**	.119**	-.020	.091**	.102**	-.008	.092**	.060	.018	.100**	.125**	-.032	.085**	.103**	-.018	.100**	.133**	-.036	.065*	.097**	-.026
Internet	.080*	.105**	-.027	.058	.117**	-.044	.057	.079*	-.017	.067*	.094**	-.029	.085**	.069*	.006	.067*	.116**	-.044	.069*	.081*	-.012
Video Streaming	.000	.107**	-.081*	-.011	.074*	-.064*	-.004	.077*	-.055	.003	.114**	-.084**	-.017	.103**	-.084**	-.009	.103**	-.085**	.038	.088**	-.039
Social Media	.047	.096**	-.041	.035	.096**	-.046	.023	.082**	-.041	.045	.100**	-.047	.072*	.045	.015	.041	.079*	-.033	.023	.104**	-.060
Boredom	-.219**	.502**	-.526**	-.207**	.398**	-.452**	-.242**	.468**	-.477**	-.194**	.502**	-.496**	-.203**	.443**	-.449**	-.140**	.386**	-.385**	-.121**	.441**	-.408**
Self-Esteem	.247**	-.071*	.217**	.244**	-.053	.222**	.270**	-.125**	.261**	.202**	-.079*	.184**	.208**	-.055	.175**	.160**	-.024	.124**	.163**	-.038	.141**
<i>Personality rowhead</i>																					
Agreeableness	.204**	.037	.107**	.138**	.091**	.035	.171**	.060	.070*	.215**	.021	.117**	.147**	.021	.081*	.198**	-.011	.139**	.165**	.024	.096**
Conscientiousness	.190**	-.140**	.232**	.191**	-.110**	.225**	.099**	-.124**	.149**	.145**	-.113**	.174**	.170**	-.114**	.192**	.150**	-.071*	.153**	.199**	-.200**	.284**
Neuroticism	-.190**	.101**	-.203**	-.174**	.078*	-.188**	-.192**	.161**	-.234**	-.110**	.104**	-.146**	-.169**	.063*	-.155**	-.138**	.039	-.121**	-.168**	.094**	-.185**
Openness	.035	-.051	.062	.018	-.073*	.068*	.006	-.006	.008	.043	-.022	.043	.013	-.017	.020	.089**	-.088**	.125**	.012	-.060	.052
Extraversion	.150**	-.074*	.156**	.141**	-.039	.134**	.130**	-.111**	.160**	.115**	-.090**	.139**	.105**	-.041	.098**	.135**	-.036	.117**	.129**	-.073*	.143**
<i>Internet Use Motives rowhead</i>																					
Enhancement	.132**	-.051	.127**	.033	-.011	.033	.149**	.030	.076*	.183**	-.063*	.160**	.111**	-.044	.104**	.205**	-.161**	.257**	.002	-.012	.011
Coping	.107**	.286**	-.146**	.069*	.247**	-.134**	.061	.296**	-.163**	.095**	.277**	-.149**	.080*	.266**	-.139**	.119**	.204**	-.077*	.116**	.219**	-.081*
Conformity	.275**	.335**	-.071*	.247**	.276**	-.023	.188**	.245**	-.046	.207**	.313**	-.106**	.228**	.310**	-.073*	.237**	.348**	-.109**	.274**	.262**	-.004
Social	.181**	.314**	-.118**	.161**	.260**	-.075*	.120**	.258**	-.099**	.155**	.303**	-.131**	.136**	.282**	-.113**	.130**	.308**	-.149**	.209**	.238**	-.030
Utility	.249**	.175**	.033	.195**	.162**	.024	.206**	.130**	.045	.217**	.148**	.024	.210**	.183**	.006	.214**	.152**	.025	.214**	.145**	.042

Notes. pos = Positive Digital Media Use Effects Scale; neg = Negative Digital Media Use Effects Scale; net = Positive Digital Media Use Effects Scale Net-Score; Gender: coding 1 = male, 2 = female, point-biserial correlation; * $p < .05$; ** $p < .001$.

Table 7
Correlations of the Digital Media Use Effects Scales (d-MUe Scales) with convergent measures.

	Overall Mean-Score			"Physical Well-Being"			"Mental Well-Being"			"Autonomy"			"Relationship with Parents"			"Peers & Social Support"			"School Environment"		
	pos	neg	dif	pos	neg	dif	pos	neg	dif	pos	neg	dif	pos	neg	dif	pos	neg	dif	pos	neg	dif
Health Related Quality of Liferowhead	.570**	-.244**	.564**	.453**	-.165**	.461**	.542**	-.252**	.524**	.511**	-.248**	.502**	.509**	-.220**	.489**	.470**	-.171**	.440**	.400**	-.226**	.443**
Positive Mental Health rowhead	.510**	-.182**	.476**	.418**	-.124**	.404**	.525**	-.219**	.490**	.445**	-.188**	.416**	.443**	-.161**	.404**	.384**	-.086**	.318**	.364**	-.178**	.382**
Life Satisfaction rowhead	.308**	-.207**	.362**	.229**	-.160**	.290**	.306**	-.235**	.359**	.245**	-.220**	.316**	.291**	-.195**	.329**	.243**	-.124**	.254**	.240**	-.158**	.282**
Sense of Control rowhead	.033	.444**	-.315**	.053	.356**	-.228**	.005	.382**	-.258**	.032	.426**	-.299**	.016	.396**	-.273**	.004	.382**	-.288**	.055	.389**	-.248**
Self-Efficacy rowhead	.314**	-.046	.243**	.251**	-.017	.200**	.283**	-.057	.223**	.271**	-.064*	.215**	.264**	-.017	.184**	.279**	-.035	.210**	.238**	-.050	.201**
Internet Use Competence rowhead	.160**	.037	.078*	.087**	.014	.054	.094**	.002	.060	.127**	.058	.035	.149**	.054	.059	.177**	.045	.082**	.169**	.020	.102**
General Positive Effects of Digital Media Use rowhead	.338**	-.007	.230**	.269**	.012	.192**	.313**	-.035	.227**	.294**	-.032	.205**	.294**	.016	.180**	.289**	.020	.175**	.249**	-.020	.187**
Problematic Media Use rowhead	-.106**	.500**	-.450**	-.117**	.410**	-.394**	-.111**	.460**	-.387**	-.112**	.472**	-.423**	-.077*	.436**	-.362**	-.071*	.397**	-.349**	-.049	.454**	-.367**
<i>Cyberbullying experiences</i> rowhead																					
Passive Perpetrator	.057	.231**	-.138**	.071*	.203**	-.099**	.017	.186**	-.116**	.017	.221**	-.155**	.020	.198**	-.128**	.046	.223**	-.139**	.106**	.184**	-.062*
Victim	.004	.256**	-.191**	.021	.170**	-.112**	-.049	.164**	-.143**	-.015	.256**	-.201**	-.023	.240**	-.186**	.002	.298**	-.225**	.079*	.209**	-.100**
<i>Negative Mental Health</i> rowhead																					
Somatic Symptoms	-.039	.498**	-.404**	-.017	.381**	-.298**	-.123**	.414**	-.363**	-.059	.465**	-.385**	-.060	.461**	-.369**	-.013	.448**	-.349**	.064*	.443**	-.281**
Obsessiveness	-.163**	.519**	-.502**	-.163**	.390**	-.414**	-.214**	.481**	-.467**	-.138**	.512**	-.469**	-.162**	.475**	-.445**	-.067*	.373**	-.328**	-.081*	.494**	-.418**
Social Insecurity	-.138**	.507**	-.477**	-.126**	.352**	-.358**	-.223**	.477**	-.471**	-.127**	.501**	-.453**	-.133**	.462**	-.417**	-.062	.432**	-.369**	-.033	.438**	-.345**
Depressiveness	-.150**	.561**	-.525**	-.124**	.423**	-.409**	-.235**	.534**	-.517**	-.138**	.555**	-.501**	-.156**	.496**	-.456**	-.082**	.451**	-.397**	-.031	.486**	-.378**
General Anxiety	-.098**	.530**	-.468**	-.088**	.399**	-.365**	-.180**	.476**	-.442**	-.099**	.520**	-.450**	-.100**	.469**	-.400**	-.042	.448**	-.368**	.005	.473**	-.344**
Aggressiveness	-.113**	.529**	-.476**	-.095**	.401**	-.371**	-.168**	.473**	-.432**	-.119**	.520**	-.463**	-.113**	.469**	-.408**	-.045	.439**	-.364**	-.036	.474**	-.374**
Specific Phobia	-.081*	.526**	-.453**	-.067*	.394**	-.346**	-.142**	.448**	-.398**	-.087**	.501**	-.430**	-.076*	.466**	-.383**	-.076*	.495**	-.426**	.033	.455**	-.312**
Paranoia	-.102**	.538**	-.475**	-.092**	.399**	-.367**	-.170**	.481**	-.439**	-.097**	.518**	-.448**	-.112**	.502**	-.432**	-.049	.451**	-.375**	.001	.470**	-.345**
Psychoticism	-.129**	.558**	-.509**	-.091**	.417**	-.380**	-.197**	.506**	-.474**	-.122**	.552**	-.489**	-.144**	.500**	-.451**	-.089**	.473**	-.418**	-.014	.481**	-.363**
Bad Appetite	-.054	.388**	-.330**	-.026	.319**	-.258**	-.116**	.320**	-.294**	-.057	.375**	-.316**	-.076*	.365**	-.310**	-.020	.317**	-.255**	.017	.341**	-.239**
Sleep Problems	-.114**	.368**	-.355**	-.114**	.298**	-.308**	-.182**	.365**	-.368**	-.079*	.359**	-.318**	-.123**	.332**	-.317**	-.025	.245**	-.203**	-.053	.338**	-.285**
Suicide Ideation	-.103**	.370**	-.349**	-.066*	.285**	-.263**	-.161**	.356**	-.348**	-.095**	.370**	-.336**	-.111**	.301**	-.287**	-.045	.298**	-.256**	-.046	.332**	-.276**
Guilt Feelings	-.123**	.410**	-.393**	-.114**	.304**	-.312**	-.211**	.404**	-.413**	-.102**	.416**	-.375**	-.124**	.357**	-.336**	-.055	.321**	-.280**	-.019	.354**	-.273**
General Negative Effects of Digital Media Use	-.068*	.410**	-.356**	-.060	.337**	-.297**	-.101**	.390**	-.332**	-.094**	.367**	-.333**	-.058	.369**	-.301**	-.060	.347**	-.303**	.022	.349**	-.241**

Notes. pos = Positive Digital Media Use Effects Scale; neg = Negative Digital Media Use Effects Scale; net = Positive Digital Media Use Effects Scale Net-Score; * $p < .05$; ** $p < .001$.

4. Discussion

This report introduced the d-MUSE Scales, a new tool for the comprehensive assessment of perceived positive and negative effects of digital media use on well-being in adolescents. Our results indicate that the d-MUSE Scales are suitable to capture effects of digital media use across various important areas of life in late adolescents (Ravens-Sieberer et al., 2014). In addition to the d-MUSE-pos and d-MUSE-neg scales, we evaluated the d-MUSE-dif score as an indicator for the degree of functional digital media use. Convergent and divergent construct validity have been indicated by correlations with a broad range of constructs. Additionally, the short version of the d-MUSE Scales including three items per factor and 18 items per scale shows similar psychometric properties and might be advantageous for younger individuals.

4.1. Two dimensions of positive and negative effects of digital media use effects across six domains of life

The assumed multifactorial structure of the two d-MUSE Scales was confirmed by the results of the CFAs. A one-factor structure for each of the d-MUSE-pos and d-MUSE-neg scales could not be confirmed, indicating that both scales do not load on one factor. However, a second-order model, modelling the d-MUSE-pos and d-MUSE-neg scales based on the latent subscales revealed good model fits. This model demonstrates that besides intercorrelations between factors both scales should be seen as two independent factors. Accordingly, the statistical results of the different models confirm the theoretical assumption of two largely independent scales assessing the positive and negative effects of digital media use on well-being.

The items of each scale fit well within the six areas of life identified as relevant for the quality of life in adolescents. These six domains have been well validated in cross-cultural samples as being relevant for evaluating well-being in adolescents (Ravens-Sieberer et al., 2014). However, it should be noted that other domains may also be relevant, and the relative importance of these domains may vary across generations. After excluding four items of the d-MUSE-neg scales, the internal consistency of the scales was good to excellent. Internal consistency could not be improved by deleting any item, which is why we decided to keep 38 items for the d-MUSE-pos and d-MUSE-neg scales. With a minimum of five items per subscale, it is thus possible to closely investigate the effects of specific areas of life. For example, the scales allow us to answer the question of whether digital media has positive effects in one specific area of life (e.g., “peers and social support”) while at the same time having negative effects in other areas (e.g., “school environment”). However, as a brief version of the two scales could be helpful in other use cases (e.g., as a quick screener for the effects of digital media use), we also checked the factor structure of a short version with three items per subscale. Similar results regarding factor structure and construct validity were found for the short d-MUSE Scales.

4.2. Balance between positive and negative effects of digital media use

The d-MUSE-dif score indicates that overall the use of digital media may have more positive than negative effects (all mean d-MUSE-dif scores were positive). While digital media use was most functional in the area of peers and social support, they were less functional in the area of physical well-being and school environment. These results are partly consistent with recent data showing that individuals with gaming disorder especially show functional impairment in the context of school and work and less impairments with regard to friendships (Montag & Pontes, 2023). Cut-off scores of the d-MUSE net score indicating functional and dysfunctional digital media use for different age ranges need to be validated in future studies.

4.3. Duality of positive and negative effects of digital media use

Correlational analyses and second-order factor analysis with the two d-MUSE Scales confirmed our assumption that positive and negative effects of digital media use may be independent from each other, representing two dimensions and not two sides of one dimension, consistent with the dual-factor model of mental health (Greenspoon & Saklofske, 2001; Suldo & Shaffer, 2008). Consistent with these results, the single item measuring general positive effects of digital media use was associated with the d-MUSE-pos scale but not the d-MUSE-neg scale, and the single item measuring general negative effects of digital media use was associated with the d-MUSE-neg scale but not the d-MUSE-pos scale. In addition, only very weak correlations were identified between the positive and negative effects within one area of life (also see scatterplots in supplementary material, Fig. S2), confirming the duality of the construct. These results underline the importance of assessing positive and negative effects as separate constructs and not as a unidimensional construct (e.g., Rosić et al., 2023).

4.4. Effects of digital media use are widely independent from usage time and motives

Research on usage times and the effects of digital media use has shown that the association is not as straightforward as initially expected. While some authors argue that high engagement in digital media use is a key factor, others suggest that factors such as a lack of alternative activities, traumatic life experiences, or a heightened sensitivity to rewards play a more significant role in contributing to problematic and pathological use patterns (Brand et al., 2019; Montag et al., 2024). In the current analyses, weak associations were found between usage times of different types of digital media (e.g., gaming, social media) and positive or negative effects of digital media use. These results support the notion that higher or more intense digital media use might not *per se* have negative effects (also see Reinecke & Oliver, 2016).

Similarly, motives for using digital media must be distinguished from the effects of its use. While a person may have learned that a specific behavior has positive and/or negative consequences, which in turn motivates them to engage in or avoid that behavior, this represents only one aspect of the ‘person’ factor. Moreover, motivation precedes engagement in a behavior, whereas effects occur as a result of that engagement. Accordingly, the low to medium associations between motives and the d-MUSE Scales emphasize the distinction between these two constructs.

4.5. Associations between positive and negative well-being and the d-MUSE Scales

The investigation of the construct validity revealed that positive effects of digital media use were positively associated with general measures of quality of life and well-being (health-related quality of life, positive mental health, life satisfaction, and self-esteem) while these measures were negatively but weakly associated with negative effects of digital media use. On the other hand, negative effects of digital media use were positively associated with negative experiences of digital media use (addictive engagement in digital media), and general negative mental health symptoms (psychopathological symptoms, boredom), while these factors were not or only weakly and negatively associated with positive effects of digital media use. These results confirm the convergent and divergent construct validity of the d-MUSE-pos and d-MUSE-neg scales. Interestingly, the scale measuring a sense of self control was not associated with positive effects of digital media use but negatively associated with negative effects of digital media use with medium effect size. Thus, having the impression that important areas of life are unpredictable or uncontrollable might be related to negative outcomes of digital media use but not with positive effects. While on the one hand digital media might be used to cope with difficult situations in life (Rosell et al., 2022),

they might also be responsible for creating uncontrollable or unpredictable situations, such as being a victim of cyberbullying (Giumetti & Kowalski, 2022).

4.6. Limitations and future research

The following limitations should be considered when interpreting our findings. First, evaluations of positive and negative consequences by adolescents might be biased. For example, effects of digital media use might be delayed, or contingencies might be veiled. It has been shown that children and adolescents (as well as elderly people) have a tendency towards immediate positive rewards while neglecting even higher delayed rewards (Lu et al., 2023). In addition, adolescents might overestimate the positive effects in fields that are important to them and underestimate the negative effects that are currently less important for them. Furthermore, subjective evaluations might be biased by social desirability (e.g., parents' views on the effects of digital media). Intropective abilities might be limited in children and adolescents due to young age, learning difficulties, or denial of negative effects (Aebi et al., 2017). However, we believe that simply investigating associations between digital media use and well-being could also be confounded, as it remains unclear which is the cause and which is the effect. Additionally, understanding adolescents' perceptions of the effects of digital media use on well-being is inherently valuable although investigating the retest reliability is urgently needed. That said, external validation of both the positive and negative effects by parents would provide a valuable complement to the assessment. A parent version thereby could be economically developed based on the d-MUSE Scales. Comparing both adolescents' and parents' perspectives could contribute to mutual understanding and reduce conflicts regarding media usage. These tools could also be used in family therapy settings (Nielsen et al., 2021).

Second, the d-MUSE Scales have been validated in a huge sample of 1001 late adolescents aged between 16 and 18. Although the questionnaire took approximately 41 minutes to complete and no attention checks were conducted, it can be expected that the attentional span of this sample of older adolescents was sufficient. Nevertheless, validity and applicability need to be evaluated in younger samples of children. We think that especially the short version of the scales with 18-items per scale would be beneficial in younger samples. Due to reduced interceptive and self-reflective abilities at younger age (Lyons & Zelazo, 2011; Murphy et al., 2017), external validations by parents and teachers might be particularly useful in such a younger sample. In addition, no pilot testing of the items, such as through cognitive interviewing, was conducted. Evaluating the items with input from children and adolescents would be an important next step to ensure that all items are comprehensible for both groups before validating the scale in younger samples.

Third, future developments of the scales might also consider if questions should be better answered for the one or two types of digital media that are most frequently used. For instance, researchers might be interested in investigating positive and negative effects of specific digital media which may be specific devices (e.g., smartphone, tablet, laptop), applications (e.g., social media, games, streaming platforms), or features (e.g., status update, profile, chat) (Meier & Reinecke, 2020). A simple modification of the item base could be used for these cases (e.g., "If you look at the past week, has your use of digital media (videogames, social media etc.) contributed to the fact ..."). Also, such modifications need to be evaluated in future research. However, since adolescents use multiple devices and applications, the term "digital media" is intended to cover digital media use in the broadest sense.

By addressing the areas of life relevant for quality of life in children and adolescents as identified during the development of the KIDSCREEN (Ravens-Sieberer et al., 2005; The KIDSCREEN Group Europe, 2006), which was validated across (most) European countries, we would expect that the d-MUSE Scales are valid for the application in other European countries. We would expect that areas of life are similar across other

cultures but their weight in contributing to quality of life might be different. Accordingly, the d-MUSE Scales need to be validated in other cultures to evaluate their generalization.

Fourth, no (partial) scalar measurement invariance could be established for the d-MUSE-pos scale between male and female adolescents, indicating that the scale may function differently across genders. Therefore, observed differences between male and female adolescents may not solely reflect true differences in the underlying construct but could also be influenced by measurement bias. This limitation should be considered when interpreting gender comparisons, and future research should further investigate potential sources of non-invariance.

Overall, the new scales for the assessment of positive and negative effects of digital media use in adolescents have the potential to significantly contribute to the understanding of healthy and pathological media use patterns and to develop use patterns that are functional and contribute to the development of adolescents' life. These use patterns might be quite individual which is why using the d-MUSE Scales in person-specific approaches (Beyens et al., 2021; Valkenburg et al., 2021) might be informative for the understanding of associations between individual characteristics, situational characteristics, use patterns and the positive and negative outcomes of digital media use. An important strength of the scale is its ability to account for the simultaneous occurrence of positive and negative effects on well-being, enabling it to capture the ambiguity of the effects that digital media use can have.

5. Conclusion

Since the emergence of digital media, the scientific community investigates both positive and negative effects of digital media use in children and adolescents. Up to now, scales assessing the effects of digital media have been unidimensional, concentrated on a specific type of problematic behavior (e.g. addictive, aggressive), a specific type of digital media (e.g., social media, gaming), or were focused on one specific area of life (e.g., sleep, mental health). The newly developed two-dimensional assessment tool and its short form have proven to be valid for measuring the positive and negative effects of digital media use. The two scales consider several areas of life relevant for the quality of life in adolescents and are free of any conceptualizations of pathologies (e.g., addictions, impulse-control disorders). The field of application of the d-MUSE Scales is broad and reaches from basic research contributing to the understanding of mechanisms related to positive and negative effects of digital media use (e.g., reinforcement and punishment learning in behavioral addictions; Antons et al., under review), educational and preventive contexts, as well as in diagnostic and treatment contexts.

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CRediT authorship contribution statement

Stephanie Antons: Writing – review & editing, Writing – original draft, Visualization, Supervision, Project administration, Methodology, Formal analysis, Conceptualization. **Anke Heyder:** Writing – review & editing, Methodology, Formal analysis. **Lena-Marie Precht:** Formal analysis, Data curation. **Elisa Wegmann:** Writing – review & editing, Formal analysis. **Magnus Liebherr:** Writing – review & editing, Methodology. **Julia Brailovskaia:** Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Software, Resources, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization.

Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: Stephanie Antons, Anke Heyder, Magnus Liebherr, and Julia Brailovskaia report financial support was provided by Mercator Research Center Ruhr. If there are other authors, they declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.chbr.2025.100621>.

Data availability

Data will be made available on request.

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