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# How Adolescents Cope with Technostress: A Mixed-Methods Approach

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## ABSTRACT


A broad stream of research strives to understand stress directly or indirectly resulting from the use of information and communication technology (ICT), commonly referred to as technostress. A group at high risk of suffering from the consequences of technostress is adolescents because they grow up using ICT daily and are still developing their identity, acquiring mental strength, and adopting essential social skills. Our research combines a qualitative and a quantitative study and contributes to an understanding of what strategies adolescents use to cope with the demands of ICT use. In qualitative workshops with adolescents, we collect 30 coping responses in five categories. A subsequent quantitative study finds gender- and age-related differences in adolescents' perception of technostress and concludes that adolescents as a group activate a broad portfolio of coping responses. Exploratory factor analysis reveals five factors underlying adolescents' activation of coping responses: *Avoid Stressful ICT*, *Follow the Rules*, *Use ICT Consciously*, *Contain Negative Emotions*, and *Acquire ICT*. We find that the coping responses related to the *Avoid Stressful ICT* factor are significantly more common among girls than boys and derive that adolescents who own more devices might have a lower tendency to *Follow the Rules*. A joint analysis of coping responses and technostress creators reveals that, not surprisingly, coping increases with higher intensity of technostress, but some coping responses break out of this pattern. With this research, we contribute to the theoretical and empirical understanding of an important phenomenon associated with digitalization's dark sides (technostress coping) in an important yet understudied population (adolescents 10–17 years of age). Future research may build on our work and investigate additional parameters determining differences in adolescents' coping behavior.

## KEYWORDS AND PHRASES

Adolescent stress; coping behavior; technostress; technostress coping

## Introduction

Digitalization is generally appreciated for making people's lives easier, increasing work efficiency and productivity, and fostering a societal transformation that leads us into a bright future. However, there are also dark sides associated with the increasing dispersion and use of information and communication technology (ICT) [17, 48, 49, 55]. Phenomena such as technostress [2, 35, 52], information overload [21], information technology (IT) addiction [57], security and privacy concerns [9], and cyberbullying [64] have the potential to significantly impair individuals' well-being and health and cause economic damage. A research stream that has gained particular

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attention in information systems (IS) literature over the past years strives to understand stress directly or indirectly resulting from ICT use, commonly referred to as technostress<sup>1,2</sup> [2, 4, 35, 62].

A population at high risk of suffering from the cognitive, psychological, and physiological outcomes of technostress are adolescents [8, 16]. They encounter ICT such as smartphones or social media daily [16], often spend more time of the day with ICT than they are at school or sleep [37], and have a significant amount of their social interactions via ICT [58]. Adolescents' interaction with ICT fundamentally differs from that of adults, with a stronger emphasis on ICT use for entertainment and communication purposes than in older age groups [33]. This usage pattern might increase exposure to stressful encounters [16] and makes the dangers an inescapable part of their lives. Simultaneously, adolescents are still amid their psychosocial development [12] and lack vital skills to deal with the rising demands of the digital world. Their struggle with developing a self-image [43] and their experience of role confusion [46] make them prone to peer pressure and addiction [7], characteristics linked to ICT use [57, 64]. Both aspects increase ICT-related demands on adolescents, potentially making them more vulnerable to technostress [16].

Despite their vulnerability, little is known about adolescents' ways of coping with technostress to prevent adverse outcomes. To the best of our knowledge, no study has yet created adequate knowledge on what coping responses adolescents activate to mitigate technostress and what individual and situational conditions influence their coping behavior. However, this perspective is highly relevant for two reasons. First, it helps advance theory on technostress coping at the example of a group of people which is presumed to be among those with the highest frequency of private ICT use and simultaneously is at high risk of suffering from its adverse outcomes. Second, it can produce practical knowledge that enables parents, teachers, and other adults to better protect the young from adverse outcomes of technostress, for example, by strengthening their coping competencies. Our research follows recent calls to shed light on the dark sides of digitalization at the individual level [56] and to examine coping in the context of technostress [47, 63]. It contributes to technostress theory by extending the understanding of technostress coping with an overview of coping responses that adolescents activate to mitigate technostress and by providing empirical evidence for differences in the activation of coping responses across adolescents and technostress creators. We investigate two research questions:

**Research Question 1:** What coping responses do adolescents activate as a reaction to technostress creators?

**Research Question 2:** What factors underlie adolescents' activation of coping responses?

We apply a mixed-methods approach [60, 61], combining a qualitative and a quantitative study. The results of the qualitative study lay the foundation for subsequent quantitative analysis. Study 1 employs qualitative workshops with 75 adolescents in three German school classes to identify technostress coping responses relevant to adolescents. It yields a list of 30 coping responses grouped into five categories. Study 2 builds on these results and analyzes data from a survey on technostress perception and the activation of coping responses with 230 adolescents ages 10–17.

Our results suggest that adolescents experience various technostress creators (highest: *Disclosure* of private information, lowest: *Complexity* of ICT) and can draw from a broad portfolio of coping responses. Exploratory factor analysis reveals five factors underlying adolescents' activation of coping responses. It unveils that adolescents' coping behavior

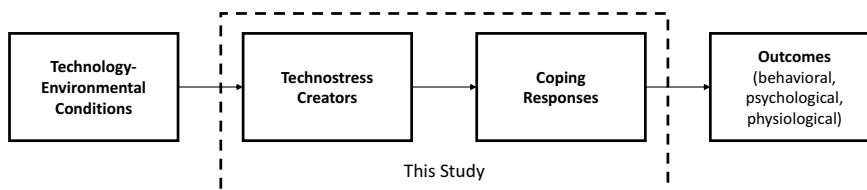
differs depending on individual characteristics such as age, gender, and the number of owned devices as well as on situational characteristics such as specific technostress creators. Although there is no “one size fits all” approach to technostress coping, our findings suggest that supporting adolescents in developing the skills and behaviors to leverage a broader portfolio of coping responses might help them meet the demands of their digital life.

## Theoretical Foundations

Early definitions describe technostress as “a modern disease of adaptation caused by an inability to cope with new computer technologies in a healthy manner” p. 16 [4] or as “any negative impact on attitudes, thoughts, behaviors or psychology caused directly or indirectly by technologies” p. 5 [62]. These definitions reflect that the use of ICT can be demanding and stressful for individuals. Since then, significant technological advances have been made. The use of ICT is no longer limited to a small number of people but ubiquitous and part of our everyday work and private life. As a result, technostress research has produced significant contributions in various disciplines to understand how ICT can create stress in individuals and what adverse outcomes can arise from technostress.

A common understanding of technostress contextualizes the transactional model of stress [24]—a framework widely used to conceptualize stress—to stress emerging from ICT use. We adopt this perspective and comprehend technostress as a process (Figure 1): An individual evaluates if the specific *technology-environmental conditions* of a situation constitute a *technostress creator* that may require the activation of appropriate *coping responses*, eventually leading to the *outcomes* of the stress reaction. This process includes two steps of appraisal (not displayed in Figure 1): Primary appraisal assesses if the situation puts a demand on the individual that might eventually cause a stress reaction. Secondary appraisal evaluates if the individual has sufficient resources (e.g., knowledge, skills, or health) and determines what coping responses could be activated. In this study, we adopt the view that the interplay of coping and appraisal can be manifold [38] and that these appraisal steps can be dynamic and arise at different points in time [38, 44, 66].

Whereas early technostress publications almost exclusively focused on the stress created by ICT used due to an organizational imperative, more and more studies recently examined the stressing effects of voluntary ICT use. These studies indicated that technostress also arises from the private use of smartphones [59] or social networks [28, 29, 30, 40] and might produce similar individual-level outcomes as organizational technostress [30, 40].



**Figure 1.** Conceptual Model of Technostress and Coping.

## Technology-Environmental Conditions

Technostress reportedly emerges from the relationship between individuals and their technological environment [2]. Individuals can perceive various conditions related to their ICT use as demanding [47]. These aspects range from general characteristics such as the ubiquity of ICT in their environment [2] over changes to the ICT environment [3] to technology-created interruptions [15].

## Technostress Creators

Combining technostress research related to organizational [2, 14, 35, 51, 52] and private ICT use [28, 29, 30, 36, 40, 64], literature holds a rich list of technostress creators. This section presents the constructs relevant to our study; Appendix A presents the complete results of our literature review on technostress creators. Our study builds on eight technostress creators: *Overload* refers to the individual's perception that ICT causes a "too much" of something—for example, communication. *Invasion* refers to the perception that ICT is ubiquitous and blurs the boundaries of work and private life. Individuals experience ICT's *Complexity* when they feel that ICT is too difficult to use and *Uncertainty* when ICT changes too often and requires the individual to adapt. *Unreliability* pertains to ICT being unstable and suffering from malfunctions. *Disclosure* manifests when ICT facilitates malicious or accidental violations of individuals' privacy. When the fast advance of ICT unsettles an individual and causes them to worry about the future, ICT creates a feeling of *Insecurity*. Individuals experience *Social Pressure* when they feel pushed by their peers to use specific ICT [28, 64]. While most technostress creators have been confirmed for both organizational and private ICT use (*Overload*, *Invasion*, *Complexity*, *Uncertainty*, *Unreliability*, *Disclosure*), some have been examined only for the work (*Insecurity*) or the private context (*Social Pressure*). The large overlap between work and private technostress creators is likely because peer expectations substitute the role of organizational requirements and create a demand [28].

Some of these technostress creators have already been researched in adolescent populations. Social overload and information overload, for example, did not prove to be considerable technostress creators for adolescents, although more than a third of the surveyed adolescents perceived that they spend too much time on social networks [27]. Instead, adolescents tend to perceive exceptionally high demands from *Disclosure* and *Social Pressure* [64]. Appendix A provides a more detailed presentation of our literature review on technostress creators in work and private contexts.

## Coping

Looking at stress (not technostress) literature, the concept of coping and individuals' ways of coping with stress have been extensively researched over the years. Coping is defined as "cognitive and behavioral efforts exerted to manage specific external and/or internal demands that are appraised as taxing or exceeding the resources of the person" p. 141 [24]. Following this definition, coping involves cognitive and behavioral responses to deal with a stressful situation. Successful coping plays a major role in preventing or reducing adverse outcomes of stress. Literature commonly distinguishes two overarching coping

styles [24]: problem-focused and emotion-focused coping. Problem-focused coping aims to change or influence the demanding situation, for example, by avoiding the stressor or requesting assistance [54]. Emotion-focused coping attempts to manipulate the emotional arousal caused by the stress reaction, for example, by meditating or building up mental boundaries [22]. While the two coping styles are somewhat abstract, individuals instantiate them using a broad range of coping responses [5, 6]. Coping behavior has been found to differ depending on different individual (e.g., age, gender, personality) [11, 13] and situational conditions (e.g., major life events, illness, ICT use) [11, 39]. Therefore, a context- (ICT use) and population-specific (adolescents) consideration of coping responses is essential.

Nevertheless, only two studies combine both perspectives and investigate *adolescents'* ways of coping with *technostress*. The first study examined technostress arising from ICT-enabled social conflicts (but not other technostress creators). It proposed five strategies (*get help from others, communicate directly, cut ties, ignore or avoid the situation, and utilize digital solutions*) for coping with socio-digital demands [65]. The other study provided evidence that girls and boys cope differently with stress from internet addiction [26]. While both studies advance knowledge on adolescents' technostress coping, they considered only a small selection of technostress creators and did not yet explore adolescents' specific coping responses to multiple technostress creators.

Extending the view to *other populations*, various studies have shed light on how individuals cope with *technostress*. Overall, these studies verify that individuals use combinations of problem-focused and emotion-focused coping strategies in stressful situations. When facing significant ICT events, individuals can pursue four adaptation strategies mixing problem- and emotion-focused coping [3] and emotions can influence the selection of these strategies [44]. Efforts to mitigate the adverse outcomes of technostress from private ICT use can be divided into five technostress interventions [39]: Both the *modification of ICT features* and the *modification of ICT use routines* target the technostress creator and attempt to reduce its effect in the long run. The *modification of personal reactions to ICT stressors* facilitate toleration of the technostress creator by improving the individual's emotional handling. In contrast, *temporary disengagement from ICT* and *online and offline venting* form the action field "recovery from strain" and can help temporarily reduce the aftermath [39]. Similar to these interventions, three types of control have been linked to technostress mitigation [15]. Exerting *method control* and *resource control* are coping behaviors in which individuals change their way of using ICT (method control) or avoid the stressful ICT environment (resource control). In contrast, *timing control* sets in earlier in the transactional process and enables individuals to influence when the demanding situation occurs [15]. Recent studies investigating specific coping responses confirmed that individuals *temporarily discontinue social media use* at high technostress levels [30] or *distract themselves*, often even on the same social network that created the technostress [50]. Likewise, individuals that have to deal with complex and demanding IT security requirements tend to *morally disengage* from the requirements [9]. A rather radical approach to technostress coping gaining increasing popularity in combatting digital overload is "digital detox" [45], the *temporary abstinence from ICT*. However, few publications have applied a broader view of what specific coping responses individuals activate to cope with technostress, indicating that research on technostress coping is still in its early stages. Various scholars have come to a similar conclusion and demand additional research efforts

to understand better how individuals can cope with the specific demands of technostress [47] or call specifically for a structured view on coping to promote greater understanding [63].

The literature on *stress* (other than technostress) coping by *adolescents* brings in another perspective. It strives to understand what adolescents can do against stress to protect them from suffering from the outcomes of high stress and ineffective coping despite having limited capabilities for coping [8]. Various studies aimed to grasp how adolescents can effectively mitigate stress and produced an informative and largely congruent portfolio of coping strategies that adolescents can pursue: The strategy *distraction/recreation* involves responses that help regulate emotions and restore or maintain emotional resources [10, 19, 67]. *Cognitive control* refers to cognitive efforts that help maintain control over one's resources (e.g., reevaluating the situation or giving positive self-instruction) [10]. While adolescents who pursue the strategy of *ruminating/venting* cannot stop thinking about the stressful situation and frequently talk about consequential feelings, *denial* refers to the opposite case, in which individuals disclaim that they have stress [6, 19]. Seeking support can help stressed individuals in two ways: *seeking emotional support* can mitigate the emotional rebound and is an emotion-focused way of coping, whereas *seeking instrumental support* aids in reducing the problem through assistance, information, or materials [5, 6, 10, 19, 67]. Further problem-focused ways of coping are *situation control*, which comprises all efforts that aim to obtain control over the problem, and *confrontation/aggression*, which corresponds to approaching the cause for social stress [10, 19]. Several studies emphasize that family can play a crucial role in conveying essential coping abilities and facilitating adequate coping responses [42]. Although stress coping literature has produced a rich list of coping responses activated by adolescents to mitigate stress, most of these studies stem from a time where ICT use was far less common. Therefore, it is not clear to what extent they transfer to technostress.

## Methodology

Our mixed-methods approach pursues a developmental purpose [60] to approach the two research questions and contribute to a better understanding of how adolescents cope with technostress. We employ a sequential design with first a qualitative study (Study 1) and then a quantitative study (Study 2) [61]. In this mix, the quantitative study is dominant [61].

Study 1 expands existing knowledge on technostress coping by developing a list of coping responses adolescents activate to mitigate technostress based on qualitative data collected in workshops with three school classes. Study 2 employs a structured online survey and quantitative analysis to collect empirical evidence for the activation of the coping responses from Study 1, evaluate patterns in adolescents' coping behavior with individual and situational parameters, and identify factors underlying adolescents' selection of coping responses. The following sections describe the methodology used in Study 1 and Study 2 in detail.

Both studies collected data in German secondary schools with the explicit consent of the school principals and the supervising teachers. We provided focused information on the study for parents to ensure compliance with ethical requirements in research with adolescents [25]. Neither of both studies puts the adolescents at risk beyond the risks of a typical

school lesson. The adolescents' participation was voluntary for the in-class sessions in both studies and the survey in Study 2. We informed them about the purpose of the research, and that aggregate results would be published. We collected data anonymously and did not grant any incentives for participation. Adolescents had the opportunity to raise concerns with us, their teacher, or the school management and/or leave the classroom for the in-class sessions. None of the adolescents did so. The participation in the survey was not mandatory but announced as voluntary homework.

## **Study 1: Qualitative Workshops**

### ***Methods***

In Study 1, we carried out interactive workshops with three classes in two mixed German secondary schools to compile a rich collection of technostress coping responses for subsequent quantitative analysis while at the same time providing educational and informative benefits to the participating adolescents. Workshops have been introduced as a valid way of collecting qualitative data [32, 41], which emerge in a collaborative, creative process [32] and satisfy typical evaluation criteria for qualitative research [18, 41]. We integrated the workshops into regular school lessons to create a familiar and safe environment where adolescents can speak freely without fear of negative consequences arising from their participation [25, 32].

A total of 75 adolescents took part in Study 1. We interacted with one seventh grade (27 adolescents ages 12–13) in an intermediate secondary school and two 11th grades (48 adolescents ages 16–17) in a higher educational secondary school. In all school classes, about half of the participants were female. Each workshop took 90 minutes and consisted of two parts of approximately equal length. All workshops were led by the same researcher who tried to stick to similar words across the workshops. In the first part, the researcher and adolescents jointly worked on establishing a basic understanding of technostress. The second part focused on technostress coping and collected coping responses that adolescents can activate to mitigate technostress.

The first part began with the researcher giving a short introduction to the concepts of stress and technostress, followed by an explanation of the eight technostress creators presented in the section Theoretical Foundations. While describing the technostress creators to the adolescents bears the risk of biasing the results to some extent, prior discussions with adolescents and schoolteachers suggested that reflection on ICT usage and technostress might only be marginal and, thus, basic information triggering reflection on one's behavior is advisable. Although most, if not all, adolescents had already experienced technostress, the theoretical concepts are likely new to them. To prevent them from getting stuck to the researchers' words, we did not provide specific examples for the technostress creators. Instead, we encouraged the adolescents to think about situations in which they or friends experienced each technostress creator and share their examples with the class. The researchers noted all examples given by the adolescents on the blackboard to be visible for the class throughout the workshop. After collecting examples for each technostress creator and having a short break, the second part introduced the concept of coping [24, 39]. Again, we did not provide specific examples of coping responses and refrained from evaluating coping as per se good or bad. Instead, we asked the adolescents to get together in groups of

three and discuss what coping responses can help mitigate technostress. Within the group work of 15 minutes, the adolescents were invited to remember or imagine situations in which they or friends felt or might feel techno-stressed and to reflect which coping responses were or could have been applied. Subsequently, each group presented their results to the class, and we recorded all potential coping responses mentioned by the adolescents on the blackboard. At the end of the groups' presentations, we photographed the blackboard and asked the adolescents to share the notes made during the group work with us voluntarily.

The workshops' procedure took care of data credibility and data confirmability [18] by producing knowledge shared by the group [41] that can be verified in future research. While the working instructions given to the adolescents might have also evoked the nomination of hypothetical but not personally tested coping responses, we argue that this open formulation is indispensable in our setting as it allows adolescents to cover their own experiences and talk openly without having to disclose personal feelings, experiences, and behaviors [25]. Similarly, we refrain from taping and transcribing the workshops to maintain privacy in the sensitive group of adolescents [25]. Instead, we collected the blackboard photographs and the notes from group work as field notes [31], which are a valid source of qualitative data in workshops [32]. We do not infer frequent activation of the coping responses directly from the qualitative analysis but perform subsequent quantitative analysis with an anonymous survey. The consistent workshop structure producing similar results in the three school classes suggests the results' dependability [18]. The detailed description here provides the basis for the results' transferability to other contexts [18].

### **Data Analysis and Results**

The adolescents participating in Study 1 suggested 36 coping responses. We grouped them into five categories of theoretically similar coping responses based on content-wise similarities and their anchoring in theory. In a card sorting, nine IS scholars familiar with technostress and coping assigned each of the initial coping responses to one of the categories and achieved a substantial level of agreement between the judges based on a Fleiss's Kappa of 0.680 [23]. As an aggregate outcome, we assigned a coping response to a category if more than half (five or more) of the judges assigned it to the category. A hit ratio, that is, the level of agreement between the judges' and our prior categorization, of .910 serves as evidence for construct validity. Several judges suggested to group highly related coping responses into broader concepts and to define some coping responses more abstractly.<sup>3</sup> This grouping reduced the initial list of 36 coping responses to 30 (Table 1). The list of coping responses fulfills the developmental purpose in our mixed-methods design and informs Study 2 for subsequent quantitative data collection and analysis.

We find that the coping responses collected in the workshops mostly relate to extant research on adolescents' stress coping or individuals' technostress coping but tend to be more specific and actionable. For example, the coping responses in our dataset describe several ways of seeking *distraction/recreation* [10, 19, 50] (as a common coping strategy of adolescents [67]; e.g., *engage in activities with family and friends* (E2), *sleep more than usual* (E4), and *distract oneself* (E3)) or *modifying one's IT use routines* [39] (as an individual's intervention strategy to mitigate their technostress; e.g., *discontinue use of specific ICT* (B1), *leave the smartphone at home* (B4), and *seek personal contact* (B5)). What is remarkable is

**Table 1.** List of Coping Responses Resulting from Study 1, Subsequently Analyzed in Study 2.

Category	Theoretical anchoring	ID	Coping responses suggested by adolescents
Emotion regulation	Responses that help the individual feel better emotionally. Emotion regulation corresponds to the technostress intervention action field <i>recovery from strain</i> [38] and includes various emotion-focused coping responses ( <i>distraction, recreation, rumination/venting, seeking emotional support, and partially cognitive control</i> ) [10, 19].	E1	Talk with others about own TS perception
		E2	Engage in activities with family and friends
		E3	Distract oneself
		E4	Sleep more than usual
		E5	Talk oneself into believing to have no TS
		E6	Seek professional help
Knowledge acquisition	Actions to collect information and acquire knowledge that helps individuals to actively reduce current technostress and prevent future technostress. Coping responses in this category aim to obtain <i>control over one's own cognition</i> [10], often draw from <i>instrumental social support</i> [5, 19], <i>modify the personal reactions to ICT stressors</i> [39], and pave the way for targeted problem-focused coping.	K1	Respect parents' advice on how to use ICT
		K2	Educate oneself on how to prevent TS
		K3	Read privacy policies
		K4	Remember school advice on how to use ICT
		K5	Take time to learn how to use new ICT
		K6	Try to understand what causes TS in oneself
Behavior adaptation	Conscious changes in behavior when using ICT in order to reduce the problem and better be able to control the situation [19]. Behavior adaptation corresponds to <i>modification of IT use routines</i> intervention [39] and exerts <i>method control and resource control</i> [15]. Examples include discontinuing the use of a specific ICT or leaving the smartphone at home when meeting friends.	B1	Discontinue use of specific ICT
		B2	Avoid aggressiveness in ICT
		B3	Limit oneself to a single device
		B4	Leave the smartphone at home
		B5	Seek personal contact
		B6	Select social networks carefully
Technology adaptation	Similarly to behavioral actions, technological actions help individuals improve situational control [19] but, in contrast to behavioral actions, <i>modify the IT features</i> (e.g., by activating the flight mode or muting crowded chat groups) instead of altering the individuals' use of ICT [39].	T1	Delete social network accounts
		T2	Adjust privacy settings
		T3	Mute chat groups
		T4	Activate silent or flight mode
		T5	Prevent sleep disturbances by ICT
		T6	Remove unneeded apps or files
Social rules	Social rules are a form of <i>instrumental social support</i> [5, 19] and a precursor of <i>modified IT use routines</i> [39], which helps adolescents take appropriate measures consciously. Multiple adolescents described compliance with parental and school rules on ICT use as a way of coping with technostress and suggested the establishment of peer rules to mitigate adverse outcomes of ICT use.	R1	Follow parents' time restrictions for ICT use
		R2	Follow parents' rules regarding ICT content
		R3	Follow parents' device rules for ICT use
		R4	Buy ICT on one's own
		R5	Make rules with friends about ICT use
		R6	Follow school rules for ICT use

**Note.** ICT = information and communication technology; TS = technostress.

that the adolescents in our study reported many problem-focused but few emotion-focused coping responses (all of which have been assigned to the *Emotion Regulation* category). A possible explanation for this is that adolescents might feel familiar with using ICT and, thus, perceive technostress creators as easier to approach than other causes of stress (e.g., social stressors). Another observation is that parental and school rules play a major role in adolescents' coping behavior. Although the adherence to social rules can be regarded rather as a catalyst for subsequent coping [42] than as a conscious coping decision, rules might directly or indirectly influence the outcome of technostress reactions and determine adolescents' behavior associated with ICT. While *seeking instrumental support* is a known

way adolescents use to cope with stress, the acquisition of ICT-related knowledge and skills seems to be of particular relevance to their coping with technostress. Exemplary coping responses are *educate oneself on how to prevent technostress (K2)* or *take time to learn how to use new ICT (K5)*.

## Study 2: Quantitative Survey

### Methods

Study 2 investigates (1) how frequently adolescents activate the 30 coping responses from Study 1, (2) how the selection of coping responses relates to individual and situational characteristics, and (3) what factors might underlie adolescents' activation of coping responses. We collected empirical data on adolescents' technostress perception and coping behavior in three schools in Germany: one higher educational secondary school with grades 5–12 and two gender-separated intermediate secondary schools with grades 5–10. The school for girls and the higher educational secondary school are in the urban area; the school for boys is in a more rural area. At least one class of each of the grades 5–10 (adolescents ages 10–17) in the higher educational secondary school and 5–9 (adolescents ages 10–16) in the intermediate secondary schools participated in the study. Overall, we reached 1,273 adolescents in 52 classes: 26 in the higher educational secondary school, and 13 in each of the intermediate secondary schools. We held a 45-minute school lesson for each participating class introducing basic information on technostress and coping. All lessons were held by the same researcher as in Study 1 and pursued the goal to set the adolescents reflecting their ICT use. Unlike in Study 1, the lessons offered less space to collect examples for the technostress creators and did not include the coping group work. At the end of the lessons, we asked the adolescents to participate in the online survey as voluntary homework.

The survey was conducted in German and consisted of three parts: The first part collected demographic data such as the participant's age, grade, gender, school type, and the number of digital devices they own. The second part asked them about the perceived intensity of the eight technostress creators. Where applicable, the items used in this part corresponded to or were inspired by existing items found in the literature. We did not find a satisfactory scale for the technostress creator *Unreliability* and constructed the scale from qualitative findings from prior studies [14]. Appendix B provides a complete list of the scales, including their source or development. We selected four to six items based on theoretical considerations to trade-off content validity and length for all scales in our survey. Several adaptations to the original items were necessary to correspond to the context of school-aged adolescents and harmonize the wording across the various items (e.g., extend the focus from items focusing only on a specific ICT such as Facebook [28]). All items in this part used a five-point Likert scale: 1 = strongly disagree, 2 = rather disagree, 3 = neither agree nor disagree, 4 = rather agree, 5 = strongly agree. The third part of the questionnaire collected information on the activation frequencies of all coping responses from Study 1, grouped by categories. In this part, participants were asked to specify how often they activate a certain coping response when they feel stressed by ICT on a five-point Likert scale: 1 = never, 2 = rarely, 3 = occasionally, 4 = often, 5 = always.

To consider that some questions might be challenging to answer, particularly for younger adolescents, only demographic questions were technically mandatory. Participants could skip items they found challenging to answer or end the survey early. We included only datasets in our statistical analyses where a maximum number of three questions on both the technostress and the coping parts remained unanswered. For data analysis, we used the statistical software R and especially its lavaan package. Most technostress creator scales have satisfactory psychometric properties; see Appendix B for a detailed description of the scale evaluation. However, the scales for the technostress creators *Overload* and *Invasion* exhibit low internal consistency and discriminant validity and are excluded from the analyses. This result is surprising since both scales build on scales frequently used to assess technostress in adult populations. Further research might develop new scales specifically for adolescents. All other scales possess satisfactory properties.

## Results

The 1,273 adolescents in 52 school classes attended the lessons and got access to the survey. 351 adolescents responded to our request to take part in the survey (27.6 percent response rate). After removing incomplete data, 230 complete datasets on technostress creators and coping remain and go into analysis. The large gap between potential and actual participants might be explained by the fact that participation in the study was voluntary. Most participants completed the survey within 10 minutes. Table 2 shows descriptive statistics of the demographics. While the survey asked for both age and grade, our analysis uses grade as a variable for the adolescents' state of development. Both constructs are substantially correlated, and grade exhibits a more uniform distribution (there were few observations of adolescents ages 10 or 17). We also exclude the school type (higher educational vs. intermediate secondary schools) from our analysis as we cannot conclude if significant effects are due to the different educational levels, the gender separation, or the location.

In the following, we report quantitative analyses of the questionnaire data on technostress creators and coping responses. For these analyses, *gender* is a dichotomous variable, where 1 refers to females (103 adolescents), and 0 refers to males. *Devices* has an ordinal scale, where 1 is used for adolescents that own a maximum of two devices (60 adolescents), 2 for those possessing three or four devices (89), and 3 for those with five or more devices (81). While we report significant differences in the following, they are observations in our sample that need to be further researched.

**Table 2.** Demographics of the Participants.

School	Classes visited	No. of adolescents	Grade range	Grade median	Grade mean	Complete responses (coping)
Urban higher educational secondary school	26	677	5–10	8	7.9	147
Urban girls intermediate secondary school	13	301	5–9	8	7.8	30
Rural boys intermediate secondary school	13	295	5–9	7	6.9	53
Overall	52	1,273				230

## Results on Technostress Creators

A prerequisite for understanding adolescents' technostress coping behavior is their perception of technostress. This paragraph gives a short overview of adolescents' technostress experiences in our sample ( $N = 230$ ); Appendix C provides a detailed description. First, empirical data suggest that technostress is a problem for adolescents, but the overall perceived intensity is, on average, lower than that of adult samples reported in the literature. Second, there are large differences in perceived intensity between the eight technostress creators. While adolescents perceive the highest demands from *Disclosure* ( $M = 3.04$ ), *Complexity* places the lowest demands on them ( $M = 1.71$ ). Third, our data indicate that gender differences exist: Girls reported significantly higher levels of overall technostress ( $M = 2.70$ ) than boys ( $M = 2.20$ ) based on a Mann-Whitney  $U$  test,  $W = 3678$ ,  $p < 0.001$ , with an effect size of  $r = 0.37$ , medium effect. To control for side effects of school form and location, we performed the same test on a subsample with only the adolescents in the urban higher educational school (73 girls, 74 boys) as a robustness check and obtained similar results,  $W = 2032.5$ ,  $p < 0.001$ ,  $r = 0.39$ , medium effect. Likewise, each of the six technostress creators is perceived significantly more intensely by girls compared with boys. Fourth, the adolescents' grade allows for a similar but slightly less pronounced observation: adolescents in higher grades report significantly higher levels of all technostress creators except *Complexity* and *Social Pressure*.

## Descriptive Statistics

Data on the coping responses unveil that many adolescents activate technostress coping responses and that large deviance in frequency between the different coping responses exists. While *remove unneeded apps or files* ( $T6$ ) is the most popular coping response with a mean of 3.70, not surprisingly, *seek professional help* ( $E6$ ) is only the ultima ratio in coping with technostress ( $M = 1.29$ ). Appendix D shows the activation frequencies of all coping responses from Study 1.

## Exploratory Factor Analysis

To better understand adolescents' coping behavior and provide relevant insights for Research Question 2, we conduct an exploratory factor analysis (EFA) exploring which factors might underlie adolescents' activation of coping responses. According to parallel analysis [20], a five-factor solution captures the variance in the data best. Although these factors partially overlap with the theoretical categorization, they are conceptually independent of the categories described in Study 1. Study 1 aimed to group *theoretically similar* coping responses; the factor analysis here aims to identify *factors that underlie the activation of coping responses empirically*. Therefore, we pose that the interpretation of these factors requires a nuanced consideration. Appendix E provides a complete list of the loadings of the coping responses on the factors.

From analyzing these loadings, we find that for four of the factors the coping responses loading on them are highly connected. Although our analysis does not fully grasp the factors' antecedents since coping responses are activated in a complex interplay of individual, situational, and environmental conditions, we identify several behavioral patterns that

might guide adolescents' activation of coping responses and name the factors accordingly *Avoid Stressful ICT, Follow the Rules, Use ICT Consciously, and Contain Negative Emotions*. There seems to be a focus on coping responses from a specific theoretical category for each of these factors. The fifth factor has a loading from the coping response R4 (*Buy ICT on one's own*) and a minor cross-loading with the *Avoid Stressful ICT* factor from T2 (*Adjust privacy settings*). We name this factor *Acquire ICT* as it seems to relate to the circumstance that adolescents buy ICT independently. The coping responses from the *Behavior adaptation* category do not exhibit an apparent pattern but distribute across three factors. Four coping responses do not load significantly on any of the factors and are subsumed under *Other* in the following.

### Relationships of Demographic Data and Coping Responses

Subsequent analyses of the coping responses reveal interesting relationships with demographic data on both the coping response and factor levels. While there is no overarching pattern (such as the finding that girls perceive higher technostress than boys for all analyzed technostress creators) for coping, the correlations between the demographic factors and the coping responses seem to be more nuanced and show different patterns across the five factors. Table 3 displays the correlations of the coping responses with demographic data,

**Table 3.** Correlations of Coping Responses with Demographic Data, Sorted by Mean Activation Frequency.

Factor	ID	Coping Response	Grade <sup>s</sup>	Devices <sup>s</sup>	Gender <sup>b,+</sup>
Avoid Stressful ICT	E2	Engage in activities with family and friends	.137*	-.251***	.185**
	E3	Distract oneself	.093	-.210**	.301***
	B5	Seek personal contact	.215**	-.213**	.265***
	B6	Select social networks carefully	.177**	-.093	.182**
	T2	Adjust privacy settings	.106	-.073	.234***
	T3	Mute chat groups	.182**	-.073	.182**
	T4	Activate silent or flight mode	.230***	-.068	.225***
	T5	Prevent sleep disturbances by ICT	.176**	-.163*	.207**
	T6	Remove unneeded apps or files	.145*	-.088	.140*
	Follow the Rules	R1	Follow parents' time restrictions for ICT use	-.155*	-.258***
R2		Follow parents' rules regarding ICT content	-.202**	-.234***	-.102
R3		Follow parents' rules regarding device use	-.106	-.259***	.006
R6		Follow school rules for ICT use	-.167*	-.217***	.009
K1		Respect parents' advice on how to use ICT	-.072	-.271***	.004
B4		Leave the smartphone at home	-.110	-.134*	.017
Use ICT Consciously	K2	Educate oneself on how to prevent TS	-.070	-.045	-.133*
	K3	Read privacy policies	-.206**	-.138*	-.004
	K4	Remember school advice on how to use ICT	-.089	-.177**	.072
	K5	Take time to learn how to use new ICT	.075	-.082	-.149*
	K6	Try to understand what causes TS in oneself	-.006	-.231***	.090
Contain Negative Emotions	E4	Sleep more than usual	.214**	.017	.181**
	E5	Talk oneself into believing to have no TS	.191**	.039	.248***
	E6	Seek professional help	-.192**	-.043	-.094
	B1	Discontinue use of specific ICT	.083	-.160*	.211**
	B3	Limit oneself to a single device	.064	-.227***	.232***
	R5	Make rules with friends about ICT use	.115	-.076	.101
Acquire ICT	R4	Buy ICT on one's own	.224***	.083	-.048
	Other	T1	Delete social network accounts	.005	-.067
E1		Talk with others about own TS perception	-.079	-.273***	.070
B2		Avoid aggressiveness in ICT	.132*	-.175**	.224***

**Note.** ICT = information and communication technology; TS = technostress.

\* $p < 0.05$ . \*\* $p < 0.01$ . \*\*\* $p < 0.001$ .

<sup>s</sup>Spearman correlations. <sup>b</sup>Point-biserial correlations. <sup>+</sup>Appendix F presents a robustness check of gender results.

grouped by factors. We discuss these relationships in the Integrated Results section. For better interpretability of the observations relating to gender, we again performed a robustness check with the urban higher educational subsample and found significant but less pronounced effects. Appendix F presents details on this analysis.

### **Relationships of Technostress Creators and Coping Responses**

In a final step, we relate the coping responses to specific technostress creators. This analysis assumes that individual differences cannot fully explain disparities in adolescents' activation of coping responses and that a situational component depending on which technostress creators the adolescent perceives as taxing might be meaningful. For this purpose, we link each participant's responses on the technostress perception and coping parts of the questionnaire and investigate correlations between both. Our analysis aims to unravel differences in the activation frequency of a specific coping response at low and at high levels of a specific technostress creator compared to medium levels. More specifically, we compare the mean activation frequency of a coping response among participants within the lower or upper quartile of perceived demands from a technostress creator with the coping response's mean activation frequency among participants in the second and third quartile of the technostress creators (middle 50 percent). For this comparison, we calculate a ratio  $q$  between the lower (or upper) and the middle quartiles, which can be interpreted as follows: A value of  $q$  below 0.9 indicates that the coping response is less frequently used in the upper or lower quartile and is represented by the symbol "--" in Table 4. Accordingly, "-" refers to values  $0.9 \leq q < 0.95$ , "o" to values  $0.95 \leq q \leq 1.05$ , "+" to values  $1.05 < q \leq 1.10$ , and "++" to values  $q > 1.10$ . These thresholds reflect that the technostress creator is one determinant of adolescents' activation of coping responses but not the only one and trade-off broad coverage and explanatory power. In Table 4, the first symbol in the cells refers to ratio  $q$  at low levels (lower quartile) of the respective technostress creator while the second symbol displays the ratio  $q$  in the upper quartile. Table 4 uses color-coding explained in the table's notes to visualize relations.

### **Integrated Results: Factors Underlying Coping Behavior**

The exploratory factor analysis in Study 2 examined underlying factors in adolescents' activation of the 30 coping responses adopted from Study 1. Five factors emerged from this analysis and painted a clearer picture of adolescents' coping behavior in response to technostress. This section provides details on the factors, investigates their theoretical underpinning with the categories from Study 1, interrelates both studies' results, and examines their relationships with demographic data and technostress creators. However, it is important to note that from the statistical relationship between technostress creators and coping responses in our cross-sectional quantitative data, one cannot deduce causality because stress appraisal and coping affect each other [38].

### **Avoid Stressful ICT**

Five of six coping responses from the *Technology adaptation* category and two from each of the *Emotion regulation* and the *Behavior adaptation* categories load high on the *Avoid*



Table 4. Relationships of Coping Responses and Technostress Creators.

Factor	ID	Coping response	Disclosure		Unreliability		Uncertainty		Insecurity		Social Pressure		Complexity	
			Low/High	High/Low	Low/High	High/Low	Low/High	High/Low	Low/High	High/Low	Low/High	High/Low		
Avoid Stressful ICT	E2	Engage in activities with family and friends	--/0	0/0	--/0	+/+	+/+	+/+	+/+	+/+	--/++	--/++	--/++	--/++
	E3	Distract oneself	--/0	0/0	--/0	+/+	+/+	+/+	+/+	+/+	--/0	--/0	--/0	--/0
	B5	Seek personal contact	--/0	0/0	--/0	+/+	+/+	+/+	+/+	+/+	0/++	0/++	0/++	0/++
	B6	Select social networks carefully	--/0	0/0	--/0	+/+	+/+	+/+	+/+	+/+	--/0	--/0	--/0	--/0
	T2	Adjust privacy settings	--/0	0/0	--/0	+/+	+/+	+/+	+/+	+/+	--/0	--/0	--/0	--/0
	T3	Mute chat groups	--/0	0/0	--/0	+/+	+/+	+/+	+/+	+/+	--/0	--/0	--/0	--/0
Follow the Rules	T4	Activate silent or flight mode	--/++	++/0	--/0	+/+	+/+	+/+	+/+	+/+	--/++	--/++	--/++	--/++
	T5	Prevent sleep disturbances by ICT	--/0	0/0	--/0	+/+	+/+	+/+	+/+	+/+	0/++	0/++	0/++	0/++
	T6	Remove unneeded apps or files	--/++	++/0	--/0	+/+	+/+	+/+	+/+	+/+	--/++	--/++	--/++	--/++
	R1	Follow parents' time restrictions for ICT use	--/0	0/0	--/0	+/+	+/+	+/+	+/+	+/+	0/0	0/0	0/0	0/0
	R2	Follow parents' rules regarding ICT content	0/0	0/0	0/0	+/+	+/+	+/+	+/+	+/+	+/+	+/+	+/+	+/+
	R3	Follow parents' rules regarding device use	0/0	0/0	0/0	+/+	+/+	+/+	+/+	+/+	+/+	+/+	+/+	+/+
Use ICT Consciously	R6	Follow school rules for ICT use	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0
	K1	Respect parents' advice on how to use ICT	--/0	0/0	--/0	+/+	+/+	+/+	+/+	+/+	--/0	--/0	--/0	--/0
	B4	Leave the smartphone at home	--/0	0/0	--/0	+/+	+/+	+/+	+/+	+/+	+/+	+/+	+/+	+/+
	K2	Educate oneself on how to prevent TS	--/0	0/0	--/0	+/+	+/+	+/+	+/+	+/+	+/+	+/+	+/+	+/+
	K3	Read privacy policies	0/0	0/0	0/0	+/+	+/+	+/+	+/+	+/+	+/+	+/+	+/+	+/+
	K4	Remember school advice on how to use ICT	--/0	0/0	--/0	+/+	+/+	+/+	+/+	+/+	+/+	+/+	+/+	+/+
Contain Negative Emotions	K5	Take time to learn how to use new ICT	--/0	0/0	--/0	+/+	+/+	+/+	+/+	+/+	+/+	+/+	+/+	+/+
	K6	Try to understand what causes TS in oneself	--/0	0/0	--/0	+/+	+/+	+/+	+/+	+/+	+/+	+/+	+/+	+/+
	E4	Sleep more than usual	--/++	++/0	--/0	+/+	+/+	+/+	+/+	+/+	+/+	+/+	+/+	+/+
	E5	Talk oneself into believing to have no TS	--/++	++/0	--/0	+/+	+/+	+/+	+/+	+/+	+/+	+/+	+/+	+/+
	E6	Seek professional help	--/++	++/0	--/0	+/+	+/+	+/+	+/+	+/+	+/+	+/+	+/+	+/+
	B1	Discontinue use of specific ICT	--/0	0/0	--/0	+/+	+/+	+/+	+/+	+/+	+/+	+/+	+/+	+/+
Acquire ICT	B3	Limit oneself to a single device	--/0	0/0	--/0	+/+	+/+	+/+	+/+	+/+	+/+	+/+	+/+	+/+
	R5	Make rules with friends about ICT use	--/0	0/0	--/0	+/+	+/+	+/+	+/+	+/+	+/+	+/+	+/+	+/+
	R4	Buy ICT on one's own	0/0	0/0	0/0	+/+	+/+	+/+	+/+	+/+	+/+	+/+	+/+	+/+
	T1	Delete social network accounts	--/0	0/0	--/0	+/+	+/+	+/+	+/+	+/+	+/+	+/+	+/+	+/+
	E1	Talk with others about own TS perception	0/0	0/0	0/0	+/+	+/+	+/+	+/+	+/+	+/+	+/+	+/+	+/+
	B2	Avoid aggressiveness in ICT	--/0	0/0	--/0	+/+	+/+	+/+	+/+	+/+	+/+	+/+	+/+	+/+

Note. Color coding: gray = positive relationship (increasing activation with increasing technostress creator intensity); yellow = lower application in the high segment; green = higher application in the low segment; white = marginal differences in low and high segments. ICT = information and communication technology; TS = technostress.

*Stressful ICT* factor. A closer look at these coping responses reveals that the factor seemingly relates to avoidant behavior, either by escaping from ICT in general (e.g., *Engage in activities with family and friends (E2)* or *Seek personal contact (B5)*) or by avoiding ICT and ICT characteristics which might create stress (e.g., *Select social networks carefully (B6)* or *Mute chat groups (T3)*). With this focus, it anchors in technostress coping literature as *controlling the situation* [19] through *modifying their use of ICT* or *modifying the IT features* [39]. The coping responses loading on the *Avoid Stressful ICT* factor are activated frequently ( $M = 3.28$ ) with all mean activation frequencies (min.  $M = 2.76$ , max.  $M = 3.70$ ) lying above the average across all coping responses ( $M = 2.71$ ). Hence, the *Avoid Stressful ICT* factor describes an underlying pattern that most adolescents access.

It has the distinctive feature that all coping responses significantly relate to the adolescents' genders. Looking at the unweighted average of the coping responses loading on the *Avoid Stressful ICT* factor, girls ( $M = 3.60$ ) activate them significantly more often than boys ( $M = 3.02$ ), Mann-Whitney  $U$  test,  $W = 3820$ ,  $p < 0.001$ , with an effect size of  $r = 0.36$ , medium effect. While this observation might obscure possible side effects arising from the school form and location, we find a similar but less pronounced pattern also in the subsample comprising only the girls and boys at the urban higher educational secondary school,  $W = 1790$ ,  $p < 0.001$ ,  $r = 0.29$ , low effect. The finding that girls show higher degrees of avoidant behavior is consistent with the literature [34, 53] and might be explained by the fact that the girls in our study tend to perceive more technostress than the boys. Further, seven of the nine coping responses show significant correlations with the adolescents' grade. A regression model investigating the linear relationship between the adolescents' mean activation frequency of coping responses with their grade reveals that escape-avoidance behavior seems to increase significantly with the grade,  $b = 0.14$ ,  $t(228) = 4.34$ ,  $p < 0.001$ , and that grade explains a significant proportion of variance in the mean activation frequency of escape-avoidance coping responses,  $R^2 = 0.08$ ,  $F(1,228) = 18.83$ .

### **Follow the Rules**

The *Follow the Rules* factor takes its name from the perception that all coping responses loading on this factor relate to behavior that is considered conscientious. These coping responses include four *Social rules* plus the two coping responses *Respect parents' advice on how to use ICT (K1)* and *Leave the smartphone at home (B4)*. They relate to information, guidelines, or rules typically provided or imposed by a third party such as parents ( $R1-3$ ,  $K1$ ,  $B4$ ) or school ( $R6$ ,  $B4$ ). Hence, we assume that adolescents with a high degree of conscientiousness resort to *Follow the Rules* coping. Adolescents showing this behavior use *instrumental social support* [5, 19] to facilitate a *modification of IT use routines* [39]. Of all coping responses loading on the factor, the activity *follow school rules for ICT use (R6)* ranks highest with a mean of 3.62. This ranking is not surprising because German schools have a general ban on mobile phone use and penalize adolescents if their device is turned on. Conversely, fewer adolescents *leave the smartphone at home (B4)*, ( $M = 2.43$ ), making it the least frequently activated coping response associated with the *Follow the Rules* factor ( $M = 2.99$ ).

The factor exhibits various interesting relationships with demographic data. First, three of the four coping responses loading on this factor are significantly related to the school

grade. A closer look reveals that adolescents in the fifth and sixth grades have a high tendency to comply with rules ( $M = 3.47$ ) but compliance drops with the grade level ( $M = 2.80$  for grades 7–10). The decline in the seventh grade allows for multiple interpretations. In our qualitative inquiry, several seventh graders mentioned that their parents have recently loosened the rules regarding their ICT use. The reduced activation frequency of rules could thus be due to a lower number of imposed rules. Also, adolescents come into the age of puberty and tend to rebel against supervisors, resulting in lower compliance with rules. Finally, we find a negative relationship between the number of devices an adolescent owns and their compliance with rules. This observation manifests in significant correlations for all coping responses loading on the *Follow the Rules* factor. A comparison of the means reveals that there is a significant difference between the three groups “two or less devices” ( $M = 3.49$ ,  $N = 60$ ), “three or four devices” ( $M = 2.94$ ,  $N = 89$ ), and “more than four devices” ( $M = 2.66$ ,  $N = 81$ ) based on a regression model,  $b = -0.41$ ,  $t(228) = -4.873$ ,  $p < 0.001$ , with an explanatory power of  $R^2 = 0.09$ ,  $F(1, 228) = 23.75$ . Again, this can be read in various ways: the possession of more devices might indicate either that parents impose fewer restrictions or that adolescents have a higher tendency to ignore these rules the more devices they have in reach.

In the *Follow the Rules* factor, there is low variance in the activation frequency for high values of *Disclosure*, *Uncertainty*, and *Insecurity*, indicating that adolescents’ compliance with rules seems to be independent of specific issues with one of these technostress creators. Considering that adolescents likely follow the rules because they must and not because they appreciate their parents’ technological competence, this insight is not surprising. Additionally, we find that adolescents who perceive either high or low intensity of *Social Pressure* tend to activate the *Social rules* coping responses related to this factor less frequently than the reference group. A possible explanation could be that adolescents perceiving high pressure from their peers might tend to ignore parental rules to meet their peers’ expectations. Likewise, those who perceive low social pressure do not feel pressured by their parents’ rules either. Contrary, adolescents apply parental rules more often when *Unreliability* is either low or high. While there is no obvious explanation for this observation, it suggests that high and low compliance with rules might relate to more confident ICT use.

### **Use ICT Consciously**

The *Use ICT Consciously* factor has high loadings of five of the six coping responses from the *Knowledge Acquisition* category. It is the only factor that relates exclusively to coping responses from one category. The theoretical anchoring suggests that conscious ICT use implements the *modification of personal reactions to ICT stressors* [39], mainly by *maintaining cognitive control* [10] or by *using instrumental support* [5, 19]. Three of the five coping responses have a significant negative association with the number of owned devices. This also manifests when investigating the relationship between the mean across all related coping responses ( $M = 2.25$ ) and the number of devices in a linear regression,  $b = -0.18$ ,  $t(228) = -2.681$ ,  $p = .008$ ,  $R^2 = .03$ ,  $F(1, 228)$ . A possible explanation might be that the more devices an adolescent owns, the less effort they put into reflecting their ICT use. Further, conscious ICT use seems to be rather independent of high perceptions of *Unreliability* and largely also of *Disclosure*. Apart from that,

the specific shaping of this factor seems to be more nuanced. Altogether, these findings indicate that the differences in the activation of coping responses associated with the *Knowledge acquisition* factor cannot be consistently explained by the individual and situational characteristics investigated in our study. Here, further analysis is needed.

### **Contain Negative Emotions**

From the five factors emerging from the EFA, the *Contain Negative Emotions* appears to be the most heterogeneous. While three of the six associated coping responses belong to the *Emotion regulation* category, the other three seem to be divergent. We find that the largest bracket encompassing the coping responses loading on this factor is the containment of negative emotions, for example, by sleeping (*E4*), self-calming (*E5*), or *Seeking professional help* (*E6*). However, the connection is less apparent for the other three coping responses. All six coping responses have in common that their distribution is left-skewed and that the mean activation frequencies (min.  $M = 1.28$ , max.  $M = 2.59$ , mean  $M = 2.10$ ) are below the overall average ( $M = 2.71$ ). The finding that the directions of correlations vary across the coping responses for all three demographic variables adds to the impression of heterogeneity. Therefore, we pose that the investigation of significant relationships for this factor does not produce valuable insights.

### **Acquire ICT**

Last, the factor *Acquire ICT* is dominated by a high loading of *Buy ICT on one's own* (*R4*) and has a minor loading of *T2*. *R4* significantly correlates with grade and seems independent of *Disclosure* and *Complexity*, but there is no consistent pattern across both coping responses.

## **Discussion**

Our mixed-methods design strived to understand adolescents' technostress coping behavior. The results of a qualitative and a quantitative study shed light upon adolescents' technostress coping and pave the way for subsequent research in the field of technostress coping. We draw several interesting inferences from each of the two studies. Combining the two studies produces a rich set of meta-inferences which is an important benefit of mixed-methods research [60].

Thirty coping responses emerged from Study 1 based on adolescents' qualitative testimonies in group work. A partitioning into five theoretical categories suggested that they cover a broad spectrum of coping responses ranging from activities supporting emotion regulation to problem-oriented responses like adaptations of ICT and their use. In Study 2, we collected empirical evidence that adolescents activate almost all coping responses adopted from Study 1 frequently (except for *Seek professional help* (*E6*),  $M = 1.28$ ), but different factors determine adolescents' activation of coping responses. Also, the activation of coping responses seems to be associated with individual and situational parameters. This inference is based on exploratory factor analysis that yields five factors underlying adolescents' activation of coping responses in our sample. For four of these factors, the coping responses loading on them pursue similar purposes and largely overlap with one of the theoretical categories from Study 1. This finding indicates that underlying behavioral

patterns shift adolescents to the activation of similar coping responses. However, the literature suggests that at least a combination of emotion-focused and problem-focused coping responses works best to mitigate technostress [3]. Table 5 summarizes the study's meta-inferences.

Correlative analysis indicates that differences in coping behavior—as determined by differences in the activation frequencies of coping responses associated with the five factors—seem to relate to gender, school grade, and the number of owned devices. These associations turned out to be nuanced across the five factors. Further analysis suggests a positive relationship between the factors underlying the activation of coping responses and technostress creators, indicating that coping responses are generally used more by adolescents who perceive high demands due to technostress and less by adolescents who perceive low demands. However, some pairs fall out of this pattern.

### Theoretical Contributions

Our research elaborated on two research questions: First, we aimed to gain an overview of coping responses that adolescents activate to mitigate technostress. Second, we strived for a broader understanding of what determines adolescents' selection of technostress coping responses. The inferences and meta-inferences obtained from analyzing the research questions in two sequential studies contribute to theory in multiple ways.

First, based on extant knowledge on technostress and coping (specifically on technostress coping by adults and on stress coping by adolescents) and qualitative testimonies from adolescents ages 10–17, we advanced knowledge of technostress coping by adolescents. This knowledge consists of five theoretical categories with 30 coping responses which adolescents can activate to mitigate technostress. The empirically developed coping responses are

**Table 5.** Qualitative Inferences, Quantitative Inferences, and Meta-Inferences.

Qualitative inference	Quantitative inference	Meta-inference	Reasoning
Adolescents draw from a broad range of coping responses to mitigate technostress.	Adolescents apply almost all coping responses, but their activation frequencies differ.	While adolescents as a group have a broad range of coping responses, not all coping responses are equally relevant to their coping with technostress.	The multi-faceted nature of technostress, along with individual, environmental, and situational differences, allows for a multi-faceted approach to technostress coping.
Some coping responses target specific technostress creators; some are perceived as effective on multiple technostress creators.	Gender and grade (related to age) play a role in the activation of coping responses. While heavy use of coping responses generally goes along with higher levels of technostress, some coping responses seem to particularly relate to specific technostress creators.	Which coping responses an adolescent activates is associated with both individual and situational factors.	Both the individual and the situational factors in part change with adolescents' development.
Adolescents' technostress coping responses can be classified into different theoretical categories.	Different factors underlie the activation of technostress coping responses by adolescents.	Adolescents' technostress coping behavior relates to factors that align with the theoretical category, indicating the existence of different coping styles.	Adolescents might be limited in knowledge and ability or might possess heterogeneous preferences regarding technostress coping.

mainly in line with research on adolescents' coping with everyday stress [10, 19]. While to date, research on adolescents' technostress coping has investigated coping responses to single demands in adolescents' ICT use [26, 65], our research complements these studies by examining coping with more technostress creators. Further, it complements these studies by providing a wide-ranging, theoretically elicited, and empirically supported set of technostress coping responses for adolescents.

Second, the broad investigation of technostress coping responses by adolescents contributes to developing a comprehensive classification of technostress coping responses [63] and stimulates further examination of differences in technostress coping behavior between adolescent and adult populations. Although our study focused on adolescents who have been underrepresented in technostress research so far, the coping responses embed and detail an existing framework on technostress coping with leisure ICT [39] for the specific context of adolescents' ICT use. While some coping responses are rather specific to adolescents (e.g., parental or school rules), various coping responses in our set have already been explored and verified for adults (e.g., *Discontinue use of specific IT (B1)* [30] and *Distract oneself (E3)* [50]). Future research can build on this and explore which coping responses generalize to other populations and what additional coping responses other populations activate.

Third, based on exploratory factor analysis, we derive factors underlying the activation of technostress coping responses. In part, these factors align with the theoretical categorization of coping responses, yet they are conceptually different and novel to technostress coping literature. They are interesting as they point to a better understanding of the diversity in technostress coping. Future research should aim for theoretically grounding and confirming this exploratory result.

Fourth, similarly to prior research [2, 11, 13, 39, 47], we observed that individual differences in the perception of technostress and the activation of coping responses exist. Therefore, the question emerges what the individual, environmental, and situational antecedents of these factors are. We provided a first analysis in this direction by investigating the effect of demographics and technostress creators and find that these parameters partially explain adolescents' coping behavior. For a complete picture, more parameters need to be considered. Hence, future research should explore further antecedents of technostress coping and test, if, for example, individual preferences, individual capabilities, environmental conditions, and further situational characteristics play a role.

Overall, our findings advance the theoretical understanding of technostress mitigation measures and contribute to interdisciplinary research on digitalization's dark sides [35, 55, 56, 64]. The study responds to recent calls to intensify research on the dark sides of digitalization at the individual level [56] and specifically on technostress and technostress coping [47, 63]. It unites different research streams on technostress and illuminates adolescents as a segment of the population that is still underrepresented in technostress research, yet highly relevant, not the least due to the size of the population and their ongoing development and vulnerability.

## **Practical Implications**

While the focus of our work is on theoretical advancement, it also suggests implications for practitioners. Our research may be taken as a reminder for ICT designers and engineers that they have a great responsibility and must factor in the psychological effects associated with the use of their products. We pose that a better understanding of what causes technostress in adolescents can enable ICT producers and providers to create ICTs that are less stressful to use [47], for example, by reducing notifications. The same counts for knowledge on effective coping, which could produce innovative ICT designs that support or deliberately leave room for coping with high demands. Our study shows which coping responses innovative ICTs might aim to strengthen. Examples might include content filters that reduce aggressive or disturbing content in ICT (B2), assistance systems that provide feedback on emerging technostress (K6), and adaptive systems that support individuals in the prevention or mitigation of stressful events, for example, by *preventing sleep disturbances by ICT (T5)* or *activating silent or flight mode (T4)* automatically.

For parents, teachers, and other adults who shape adolescents' social and technical environment, our results might be valuable to understand the current limitations and theoretical possibilities of adolescents' coping with technostress. Prescriptive knowledge from our mixed-methods study indicates that areas for improvement in adolescents' environment exist. Most important, adults may support adolescents in acquiring broader competency in coping with technostress, for example, by training effective coping in school or at home, by providing targeted emotional and instrumental support, or by setting rules on whether, where, when, and how to use different ICT.

Finally, adolescents themselves might find value in our results. Given our experience in discussing technostress and coping with adolescents as part of this research, we do not believe that this paper's presentation is ideal for engaging adolescents in reflection and improvement of their ICT use and coping behavior. Nevertheless, given our experience with in-class discussions, we believe that a target-group specific presentation of the theoretical knowledge in this paper might support adolescents in reflecting their ICT use, improving it, and becoming more potent at coping with stressful events. We believe that the evidence for differences in coping behavior is, in part, an indication of limited knowledge and ability to leverage the broad set of coping responses available in general—but heterogeneous preferences in coping might also be a factor. Nevertheless, reflection and training might help extend the behavioral tool set for coping with the demands of ICT use individually and in the social context.

## **Limitations and Future Research**

The work at hand has some limitations. First, parts of the research design might have influenced our results. In Study 1, adolescents had the opportunity to cover their own experiences by describing hypothetical coping responses. Further, we did not record the workshops but used field notes as a substitute. The workshops' public format might have limited the nomination of activated coping responses that are not socially desirable. In Study 2, the conduction of workshops before the survey might have biased the results on the technostress questionnaire. Additionally, the results are difficult to interpret for adolescents of the fifth and sixth grades. This difficulty is partly due to a lack of reflection on ICT use

and partly due to the lower response rate at that age. A topic for future research is that technostress and technostress coping should be explicitly investigated for such young, and even younger, children.

Second, the observations regarding gender differences and avoidant coping might include side effects with school form and location. Although robustness checks with only the adolescents from the urban higher educational secondary school with a uniform distribution of the two genders allow for similar observations, the differences might be less pronounced than assumed.

Third, internal consistency for the scales of the technostress creators *Invasion* and *Overload* in the measurement model is relatively low, so that these two constructs had to be removed from the analyses. The scales should be further investigated and adapted for future investigations with adolescents. Our data-driven analysis of the interrelation of individual technostress creators and coping responses also allows for more elaborate and theory-driven approaches. Finally, we did neither discuss nor measure the potential positive effects of technostress (eustress) or the psychological and physiological outcomes related to stress and coping.

The following four directions for future research appear promising to extend our findings: First, mitigating technostress for adolescents by shaping their technical environment: In line with other researchers [47], we call upon IS scholars to take the perspective of design science research and develop design knowledge for sociotechnical systems aware of the user's stress [1] and assist them in coping with high demands. Examples could be providing feedback on stress perception, training and expanding coping abilities, or performing automatic actions that help individuals cope. Our insights regarding adolescents' specific coping responses might support this.

Second, mitigating technostress for adolescents by shaping their social environment: Scholars may aim to analyze and design strategies and tactics for individual and collective ICT use and social support for adolescents experiencing technostress. Third, mitigating technostress for adolescents by supporting their skills: Future research should expand on why adolescents cope differently from each other and what individual, environmental, and situational antecedents determine factors in coping behavior. This investigation should also include if, besides knowledge and abilities, heterogeneous preferences might be a reason. Fourth, scholars might use the coping responses, categories, and underlying factors in theorizing on technostress coping at the workplace.

## Conclusion

This paper investigated what coping responses adolescents activate to cope with technostress and what factors underlie their activation of coping responses. We employed a mixed-methods design, starting with a qualitative study and following up on the results with a quantitative study. In the qualitative Study 1, we performed workshops with 75 adolescents in three school classes on their coping responses to technostress. Study 2 used the coping responses identified in the qualitative study for in-depth quantitative analysis. This analysis examined adolescents' self-reported frequency of activating the coping responses adopted from Study 1 based on 230 complete survey responses. It investigated their interrelations with demographic factors and technostress creators and provides evidence

for five factors that might underlie adolescents' coping behavior. Jointly, the results of both studies paint an informative picture of adolescents' technostress coping.

## Notes

1. While the IS discipline uses the term *technostress*, psychology or communication studies use the term *digital stress* (e.g., [36, 64, 65]) to refer to “stress reactions elicited by environmental demands originating from ICT use” p. 3, [36].
2. Although stress can also act as a challenge (so-called eustress) [47], the predominant focus of stress research in both psychology and IS literature is on the harmful effects of stress (distress). In this paper, we focus on techno-distress.
3. Following the judges' suggestions, we merged the coping responses *listen to music*, *read a book*, and *go for a walk* to the new coping response *distract oneself* (E3), combined *family activities* and *meet with friends* to *engage in activities with family and friends* (E2), generalized *gather information*, *introspect*, and *build up awareness* to *educate oneself on how to prevent TS*, and abstracted *activate blue filter to prevent sleep disturbances by ICT* (T5).

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