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# What really bothers us about work interruptions? Investigating the characteristics of work interruptions and their effects on office workers

Vera B. Rick[a], Christopher Brandl[a,b], Jens Knispel[c], Veneta Slavchova[c], Viktoria Arling[c], Alexander Mertens[a] and Verena Nitsch[a,b]

[a]Institute of Industrial Engineering and Ergonomics, RWTH Aachen University, Aachen, Germany; [b]Fraunhofer Institute for Communication, Information Processing and Ergonomics FKIE, Fraunhofer FKIE, Aachen, Germany; [c]Institute of Psychology, Research Group Health Psychology, RWTH Aachen University, Aachen, Germany

**ABSTRACT**

Understanding the mechanisms of work interruptions is crucial for reducing employee strain and maintaining performance. For this purpose, a study was conducted that examined how different interruptions and different characteristics of an interruption affect employees' self-reported exhaustion. Specifically, a survey examined the effect of work interruptions due to different interruption types (email, short message, call, person) from different senders (e.g. supervisor, colleague) and with different contents (e.g. new task, relevant information). Data were gathered from 492 office workers in Germany during one working day. Structural equation models were calculated to assess mediation and moderation to answer the question to what extent characteristics of work interruptions have a negative impact on employees´ burnout symptoms. The results indicate that work interruptions cannot be examined purely on the basis of the frequency but must be considered in relation to the resulting overload, whereby different characteristics of work interruptions have different effects for the interrupted person. The results underline the importance of considering work interruptions in a more complex way than has previously been done to derive guidelines for human-friendly digital work design.

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Work interruptions; burnout; well-being; stress; digital work; office work

## Introduction

Work interruptions come in various forms, such as emails, instant messages, telephone calls or colleagues seeking a listener. Whilst there also seem to be some positive effects of interruptions (e.g. Feldman & Greenway, 2021), research overall demonstrates that work interruptions are considered one of the most common work stressors (Baethge et al., 2015; BAuA, 2020), and the resulting overload can lead to the individual's inability to

CONTACT Vera B. Rick v.rick@iaw.rwth-aachen.de
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cope with the job demands, resulting in e.g. slower work rates, slower responses to critical events as well as higher error rates (Sharples & Megaw, 2015). In the long-term, this increases the risk of serious health issues, long-term sick leave or early retirement (Stansfeld & Candy, 2006), which is why understanding work interruptions is crucial for reducing stress and thus for the physical and mental health of employees in the long term. However, majority of previous research activities on this topic have been conducted specifically in the context of health professions, considering especially face-to-face (F2F) interruptions. Furthermore, the results of this research may not necessarily generalise to other occupational fields, as it can be assumed that interruptions have different effects depending on the severity of the possible consequences (Rigotti, 2016).

In order to gain a profound insight into the influencing factors as well as the effects of work interruptions with regard to office workplaces, the present study analysed the relevant literature and conducted a survey that investigated work interruptions caused by incoming emails as well as incoming instant messages, phone (or virtual) calls and F2F interruptions. In addition, the influence of different senders and different contents was taken into account. Hence, it was ascertained whether certain characteristics of an interruption can have stronger or weaker effects on workers´ burnout symptoms, which can be considered as an indicator of workers' well-being (Schaufeli et al., 2009). Following the World Health Organisation (2021) burnout can be described as an occupational phenomenon, resulting from chronic workplace stress that has not been successfully managed and is characterised by energy depletion and exhaustion, feelings of negativism or cynicism related to one's job, and reduced professional efficacy.

## *Definition and theoretical background of work interruptions*

Following Brixey et al. (2007) work interruptions can be defined as a temporary suspension of goal-directed action. The interruption can be initiated externally or internally, whereas this study focuses on externally initiated interruptions caused by unplanned tasks within the completion of a primary task, as defined following Baethge and Rigotti (2013). As a rule, it can be assumed that work interruptions are resulting in a new action. This differentiates work interruptions from distractions (e.g. background noise), which are not connected with a concrete action goal. As a theoretical description, the framework of Action Regulation Theory (ART) is suitable for the classification of work interruptions: ART is a theory of self-regulated, goal-directed behaviour that is widely used in occupational psychology and has already been applied as a theory to explain work interruptions (Baethge & Rigotti, 2013; Russell et al., 2007; Zijlstra et al., 1999). In contrast to other theories that consider interruptions as isolated events that affect immediate (or short-term) task performance (e.g. distraction-conflict theory; following Speier et al., 1997), ART treats a work interruption as a general work stressor that has a long-term impact on overall task performance (Hacker, 2003). Following the ART, actions are constantly regulated, that means adapted to external conditions. This happens in sequential phases, starting with goal setting, followed by the selection of action plans, the actual execution of actions and the subsequent monitoring and obtaining of feedback. Each planned or executed action requires individual cognitive resources, whereby the individual's performance increases to the extent that one's own actions can be regulated to achieve the goal (Frese & Zapf, 1994; Raabe et al., 2007).

In this context, work interruptions are to be seen as general work stressors that hinder action regulation and are therefore to be classified as regulation obstacles, a stimulus in the work environment that hinders action regulation and thus goal achievement (Frese & Zapf, 1994). As a result, interruptions (and other regulatory obstacles) increase stress and cognitive load (Baethge & Rigotti, 2013), as they interrupt the workflow, require additional effort (e.g. repetition of steps) or involve risky actions (e.g. skipping or rushing steps) (Frese & Zapf, 1994).

### *Work interruptions at office workplaces*

There are surprisingly few studies that have analysed work interruptions at office workplaces. Most studies have investigated them in other occupational contexts (especially the health sector) or in the context of laboratory experiments (Puranik et al., 2020; Rigotti, 2016). However, previous research shows various negative effects. An increasing frequency of work interruptions impacts health-related outcomes and leads to higher emotional exhaustion (Cheng et al., 2020), higher psychosomatic complaints (Keller et al., 2020), lower general well-being (Fletcher et al., 2018; Lin et al., 2013; Stocker et al., 2019) a higher fatigue on the following workday (Fritz et al., 2020) and higher physical complaints (Lin et al., 2013). In terms of work-related effects, a higher frequency of interruptions correlate with a lower satisfaction at work (Keller et al., 2020), lower perceived performance (Khoshbakht et al., 2021). According to Gerich and Weber (2020), the individual evaluation of work interruptions (and job demands in general) is an important mediator between demands and their effects on work attitudes and mental workload, which suggests that it is not the sheer number of work interruptions but the individual evaluation that mediates the effects for the interrupted person. This is underlined by other research, which suggest that the more the current level of email use deviates from the desired level, the higher the experience as a stressor at work (Stich, 2020; Tams et al., 2020). The mediating effect of interruption perception has already been demonstrated in relation to general workload (Rick, Brandl, Mertens, & Nitsch, 2024), but has yet to be investigated in relation to health-related effects.

In addition to the many negative effects of interruptions, however, some positive effects are also discernible. Feldman and Greenway (2021) showed that more than a quarter of respondents associated work interruptions with positive feelings, moderated by the time worthiness, timing, duration and task expectancy of the interruption, which in turn was additionally moderated by the relationship with the sender of the interruption and the work context. This finding is also supported by the study of Meyer et al. (2021) and Sonnentag et al. (2018), in which participants do not perceive interruptions as fundamentally negative but as constructive, at least in certain work phases.

### *Perceived interruption overload as a mediating variable*

In the context of technostress research, the concept of perceived interruption overload was introduced, which refers to the individual evaluation of interruptions in terms of perceived overload, thus affecting the ability to meet other demands (Chen & Karahanna, 2018; Tams et al., 2020). Perceived interruption overload describes the extent to which individuals feel that they receive more interruptions than they can effectively handle.

This is attributed to the cognitive resources required when person switches focus between tasks and is based on the literature on cognitive workload. Even though the described research on perceived interruption overload refers to interruptions in leisure time; in the work context, as already described, the study by Gerich and Weber (2020) and Rick et al. (2024) underlined the importance of the individual evaluation as a mediating variable. It is therefore assumed that perceived interruption overload mediates the relationship between interruption frequency and health-related outcomes, from which the following research question is derived:

- RQ1: Does perceived interruption overload mediate the relationship between the frequency of work interruptions and employee burnout symptoms?

### *Differences in work interruption types*

Although interruption types differ in predictor and outcome relationships, the source of interruptions has been largely neglected in the literature (Jett & George, 2003; Leroy et al., 2021). There are various external sources of interruption (e.g. F2F interactions, emails, phone calls, instant messenger chats) that differ in their characteristics, such as the interaction channel, the sensory cues associated with it, the information content, and the flexibility they provide in deciding when to interrupt or to answer an interruption (Ou & Davison, 2011). According to previous research, different types of interruptions are associated with different effects for the worker. For example, instant messaging (IM) has been shown to have the potential to play an important role in group work by strengthening intercommunication and interconnectivity. As Ou and Davison (2011) pointed out in their study, IM tools do contribute to work interruptions, but the actual impact is minimal due to the higher interactivity and communication quality. This is also underlined by the positive effects of interruptions already mentioned above, which were all carried out in the context of interruptions due to instant messages. There are similar results for F2F interruptions. When looking at F2F interruptions, it becomes apparent that they can create a positive atmosphere, especially in the office context (Szóstek & Markopoulos, 2006). In addition, F2F interruptions are often contain relevant information (Dabbish & Baker, 2003), which can put the costs incurred by the interrupted person into perspective (Feldman & Greenway, 2021). In contrast, most of the interruption research to date indicates negative effects for the employees (Puranik et al., 2020; Rigotti, 2016). Work interruptions in general, and email-related interruptions in particular, are associated with negative effects, including slower work pace, slower response to critical events, and higher error rates (Sharples & Megaw, 2015). However, the differentiation of different types of interruptions is mostly not undertaken and sources of work interruptions are usually studied separately, or the focus is on their overall frequency, which is why comparisons between different sources are only possible to a limited extent (Puranik et al., 2020). Accordingly, different sources of external interruption can be expected to have different effects on the worker. The following research question, therefore, addresses the possible differential effects of work interruptions, assuming that different types of interruptions affect interruption overload directly and burnout symptoms indirectly to varying degrees. According to previous research, it is assumed that especially the frequency of emails predicts

interruption overload, while F2F interruptions as well as short messages have less or no effect on interruption overload. Hence, the following research question was formulated:

- RQ2: Do different types of external interruption predict perceived interruption overload to different degrees?

### *Influence of the interrupting sender*

Following the literature review of Puranik et al. (2020), the characteristics of the person interrupting have not been widely studied, even if they prove to be a relevant moderator. On the one hand, interruptions by organization-external persons (e.g. project partners, customers) can be distinguished from interruptions by organization-internal persons (e.g. supervisors, colleagues); furthermore, research results indicate that a distinction must be made between the hierarchical level of the interrupting person in relation to the interrupted person. This is due to the attributes associated with the interrupting person. Being interrupted can create evaluative pressure – the feeling that one's own performance is being evaluated (Baron, 1986). The extent of this evaluative pressure depends on the hierarchical level of the interrupting person; if the interrupting person is a superior, there may be a high evaluative pressure; if the interrupting person is a subordinate, the interruption may not be perceived as sufficiently distracting and may not even trigger an attention conflict. In summary, high evaluative pressure is associated with higher attentional conflict and may increases the (negative) effects of interruptions (Baron, 1986). In this context, Gupta et al. (2013) were able to demonstrate that employees respond differently to work interruptions by supervisors than to interruptions by peers. They found that interruptions by supervisors were given more importance, took up more time and resulted in lower task performance quality than interruptions by peers. In addition, workers were found to feel unable to delay work interruptions by supervisors compared to interruptions by other people (Rennecker & Godwin, 2005).

While interruptions by persons belonging to the company can probably be better assessed and evaluated, interruptions triggered by external persons require to evaluate and assess the situation differently. As described by Böhle and Weihrich (2020) interacting with clients or costumers involves a co-human process that is co-created by the counterpart and limits predictability and plannability. Psychological, especially emotional, comprehensibility is a necessary condition for successful interaction. Thus, quite different requirements and expectations are likely to play a role in interruptions by clients or costumers than in interruptions by co-workers.

Finally, the relevance of interruptions by family members during working hours proves to be a relevant stress factor as well. Non-work interruptions and distractions most strongly predicted emotional exhaustion following Leroy et al. (2021) and can be associated with stress reactions in the context of resource depletion (Du et al., 2018) and thus have a negative impact on workers' satisfaction as well as on their respective states of resource availability.

In order to address these aspects, the effects of different senders on the perception of interruptions were analysed. The sender analysed were: (1) Interruptions by persons of a higher hierarchical level (e.g. supervisors), (2) the same hierarchical level (e.g. colleagues), (3) a lower hierarchical level (e.g. subordinate), as well as by (4) external

persons (e.g. project partners, customers) and (4) family members (e.g. family and friends). Based on previous research, it is assumed that a higher frequency of interruptions by superiors (higher hierarchical level) as well as external persons and family members in particular influence perceived interruption overload positively.

To date, research has predominantly concentrated on a frequency-based approach, which posits that different interruptions have similar effects on individuals and that their overall impact is determined by the accumulation of these effects rather than qualitative differences (Sonnentag et al., 2018). However, this makes it difficult to consider characteristics of interruptions that may alter the effects on workers (Puranik et al., 2020). Therefore, the present study adopted the proposal of Puranik et al. (2020) which combines the event-based and frequency-based approaches by considering the relative frequency of interruption characteristics. In this sense, the senders of interruptions were considered based on their relative frequency. Moreover, following the framework of Puranik et al. (2020), all characteristics of interruptions are analysed as moderators, as they can potentially influence the impact and severity of interruption frequency. Accordingly, the following research question was formulated:

- RQ3: Is the relationship between the frequency of work interruptions and perceived interruption overload moderated by the sender of the interruption?

### *Influence of the interrupting content*

Regarding the influence of the content of the interruption, the results are also not consistent (Puranik et al., 2020). Aspects investigated are in particular the complexity of the interruption, the duration as well as the similarity to the primary task, whereas a conclusion regarding the effects is not possible. This may be due to different variations in the way operationalisation was done (Mark et al., 2008) or due to wrong assumptions regarding the type of the relationship (Baethge et al., 2015). Furthermore, there is little research on the actual content of an interruption in the field of office work. Basically the content of interruptions can be divided into work-related and non-work related information (Leroy et al., 2021). Although work-related content can vary, a rough distinction can be made between the interrupting person searching for information, meaning the interrupted person is sharing information or the interrupting person receives information (Sasangohar et al., 2015). However, there is a lack of research regarding actual differential effects on the worker. In this context, information overload also plays a decisive role, i.e. receiving more information than can be effectively processed, whereby amplification occurs due to a low information content or a complete lack of relevance for the recipient (Drössler et al., 2018).

Following the explanations, it can be assumed that the content of an interruption can change the effects, even if there are hardly any concrete research results on this. Therefore, five different contents are considered in this study: (1) Relevant work-related information for the interrupted person (e.g. information for the current work task); (2) new work tasks for the interrupted person; (3) work-related information needed by the interrupted person (e.g. questions from colleagues); (4) irrelevant work-related information (e.g. information which is not relevant for the interrupted person); (5) non-work-related information (e.g. regarding private appointments). As described above, in the

context of the sender of interruptions, the present study focuses on a combined approach that considers the relative frequency of interruption characteristics. Based on Puranik et al. (2020), this approach involves including the relative frequencies of interruption characteristics as moderators so that it can be examined whether different characteristics can alter the effects of interruption frequency on the interrupted person. In this context, the following research question was investigated:

- RQ4: Is the relationship between the frequency of work interruptions and perceived interruption overload moderated by the content of the interruption?

## Method

### *Procedure*

The present study was conducted over a full workday with a pre- and post-survey. A combination of an event- and frequency-based approach was used, by considering the relative frequency of the different characteristics as suggested by Puranik et al. (2020). The event-based approach was used to collect data on work interruptions during the workday. A record was made each time a specific type of event (in this case, an interruption) occurs (Nezlek, 2020). For the analyses, based on the characteristics, the relative frequency of different interruptions were calculated. The study was conducted in January 2022. Data were collected via an online survey. Participants were contacted through a survey panel provider who accessed a random sample of panel members who met the inclusion criteria for the survey (at least 18 years old and no older than 67 years, office job, full-time employment). Participation was voluntary, anonymity and confidentiality were guaranteed. Respondents received financial compensation for their participation. As the study fulfilled a list of standard criteria set by the ethics committee (e.g. anonymized participation, adult participants, no intrusive measures, no deception), further ethical approval was waived. The test persons could choose any day within a period of three weeks on which they wanted to participate. Specifically, a study was conducted in which workers first reported on their burnout symptoms in a baseline survey (t1), then counted and characterised work interruptions during one full workday (t2) and finally evaluated their burnout symptoms again at the end of the working day as well as the work interruptions that occurred (t3). A multi-stage screening of the responses received was carried out to ensure sufficient data quality. Implausible completion times were identified, using the relative speed index (Leiner, 2019) and two items were used to test attention (Shamon & Berning, 2020). Furthermore, counted work interruptions were tested for outliers, whereas outliers were identified with the help of boxplot diagrams.

### *Sample*

The sample consisted of 492 full-time office employees working in Germany. Both, gender and age distribution are representative of the German working population (Federal Institute for Population Research, 2022). Although not the primary focus of this study, it is known that some contextual factors as well as characteristics of the employees can influence the effects of work interruptions. Therefore, the office setting itself, as well as

whether work is done from home, was recorded. In addition, age and affinity for technology were assessed. More than 80% of the participants worked alone or with at least two other employees in an office. Whether working in an office or from home was almost equally distributed. An overview the sample characteristics is given in Table 1.

## Measures

The questionnaire was divided into three parts: The first part was completed before the start of the working day (t1), the second part during the working day (t2) and the third part at the end of the working day (t3).

### Pre-work measures (t1)

The first part of the survey included questions related to the person's demographic data (gender, age, position, professional experience, working hours and questions related to the workplace, including the main work tasks). Furthermore, participants were asked to state how they are feeling using the scale to measure burnout symptoms following the German version of the Copenhagen Psychosocial Questionnaire (COPSOQ) (Lincke et al., 2021). Afterwards, the procedure was further explained, in particular what constitutes a work interruption and when and how the participants should note them. In this regard, it was pointed out to note how often one was interrupted at work by others, whereby "others" refers to all persons encountered in the daily work routine, including supervisors, colleagues and persons from one's private environment (e.g. family and friends). It was also emphasised that an interruption can be caused not only by a physical person, but also by an email, phone call or text message. It was stressed that all noted interruptions should be external interruptions and not internal interruptions or distractions. As a support, a template was provided, following the categorisations explained in the following section Workday measure. A full overview of the measures used can be found in FigShare, https://doi.org/10.6084/m9.figshare.24994679.v2.

**Table 1.** Sample demographics.

| | | *N* | % |
|---|---|---|---|
| Gender | Female | 224 | 45.5 |
| | Male | 265 | 53.9 |
| | Other | 3 | 0.60 |
| Age | 18–39 | 184 | 37.3 |
| | 40–49 | 133 | 27.0 |
| | 50–67 | 167 | 35.7 |
| Position | Management | 163 | 33.1 |
| | Employee | 321 | 65.2 |
| | Other | 8 | 1.6 |
| Office layout | Single office | 186 | 37.8 |
| | 2–3 persons per office | 281 | 44.3 |
| | Open workspace | 25 | 17.9 |
| Working from Home | None at all | 168 | 34.1 |
| | Up to 50% of the working time | 101 | 20.6 |
| | Up to 75% of the working time | 37 | 7.5 |
| | More than 75% of the working time | 186 | 37.8 |
| Professional experience [low (1) to high (7)] (*M/SD*) | 5.9 (1.13) | | |
| Working hours / week [hours] (*M/SD*) | 40.1 (4.81) | | |
| Technical affinity [No (1) to complete (5)] (*M/SD*) | 2.8 (1.34) | | |

### *Workday measure (t2)*

The participants were asked to note down each incoming interruption and, on the one hand, to name the type of interruption (email, instant message, phone/virtual call, F2F, other) and on the other hand to name the sender and content of the interruption (Table 2). The categories were tested in a pretest, after which additional descriptions were added to ensure a better understanding. The category "others" was added to give participants the opportunity to enter interruptions that they could not clearly assign to any of the other categories.

### *Post-work measures (t3)*

In the evening, the participants were asked to input the noted interruptions into the questionnaire, following the stress-oriented task analysis (ISTA) questionnaire (Zapf, 1993). Afterwards, the participants were asked to rate their perceived interruption overload (Tams et al., 2020) and to state how they are feeling at the moment using the scale to measure burnout symptoms following the COPSOQ (Lincke et al., 2021), both adapted to the context of the study. Job burnout, the feeling of exhaustion, cynicism about one's work, and reduced job efficiency, can be measured as a changing state over the course of a workday. Fluctuations are to be expected even in this short period of time. While burnout syndrome may not develop over the course of a workday, critical events at work can produce daily states of exhaustion, cynicism, and diminished job performance that, if cumulative and unaddressed, can lead to a permanent state of burnout (Xanthopoulou & Meier, 2014). In line with the scale used in the COPSOQ questionnaire, the present research focuses on the measurement of exhaustion as one dimension of burnout. This choice was made deliberately as it has been shown in previous diary studies to be a valuable measure which can show fluctuations over the course of one day (Podsakoff et al., 2019; Poetz & Volmer, 2022; Volmer & Wolff, 2018). Therefore, measuring exhaustion as an indicator of burnout symptoms as an outcome variable is useful, even for this short period of time. A complete overview of the post-work measures can be found in FigShare, A full overview of the measures used can be found in FigShare, https://doi.org/10.6084/m9.figshare.24994679.v2.

**Table 2.** Categorisation for work interruptions.

| | Category | Label |
|---|---|---|
| Interruption type | E-Mail | Mail |
| | Instant Message | IM |
| | Phone call (including virtual calls) | Call |
| | Face-to-Face | F2F |
| | Others (not analysed) | – |
| Interrupting sender | Higher hierarchical level (e.g. supervisor) | M1.1 |
| | Same hierarchical level (e.g. colleague) | M1.2 |
| | Lower hierarchical level (e.g. subordinate person) | M1.3 |
| | External person (e.g. customer, client) | M1.4 |
| | Private environment (e.g. family & friends) | M1.5 |
| | Other (not analysed) | – |
| Interrupting content | Receiving work-related *relevant* information (e.g. information for current work tasks). | M2.1 |
| | New work tasks | M2.2 |
| | Sharing work-related information (e.g. questions from colleagues). | M2.3 |
| | Receiving work-related *irrelevant* information | M2.4 |
| | Non-work-related information (e.g. socialisation, information on private appointments) | M2.5 |
| | Other (not analysed) | – |

### Analyses

After pre-processing the data as described in the Procedure section, structural equation models (SEM) were calculated in order to analyse if perceived interruption overload mediates the relationship between the frequency of work interruptions and employees´ burnout symptoms and if the sender and the content of the interruption moderates the relationship between interruption frequency and perceived interruption overload. Analyses were performed by computing SEMs using R version 4.2.1 and the package lavaan, version 0.6-12. The maximum likelihood estimation, a full information method, whereby all free parameters are estimated at once, was used. Furthermore, the Satorra-Bentler scaled chi-square test ($\chi^2$) was calculated because it is robust to non-normality. To make the model even more robust, the standard errors and confidence intervals were based on an estimate from 5000 bootstrap samples. The goodness-of-fit of the models was evaluated using multiple fit indices following Kline (2016): Comparative Fit Index (CFI), Root Mean Square Error of Approximation (RMSEA) and Standardised Root Mean Square Residual (SRMR).

In a first analysis, only the mediating influence of perceived interruption overload on the relationship of frequency of work interruptions due to emails, instant messages, phone calls and F2F contacts on burnout symptoms was examined in order to answer RQ1 and RQ2. The mediating role of perceived interruption overload was tested using the recommended procedure for testing mediational models in SEM, where the magnitude of indirect effect (product term of path a and path b) is tested using bootstrapping procedures to calculate the 95% bias-corrected confidence intervals (CIs) (Hayes, 2022). The direct and indirect effects were estimated simultaneously. To be sure to examine changes in the outcome measure, burnout symptoms reported in the pre-survey (t1) were included in the model as a predictor for the burnout symptoms at the end of the working day (t3) (Figure 1). To control for possible effects of confounding variables, the model was controlled for age and professional experience based on our correlation analysis described below.

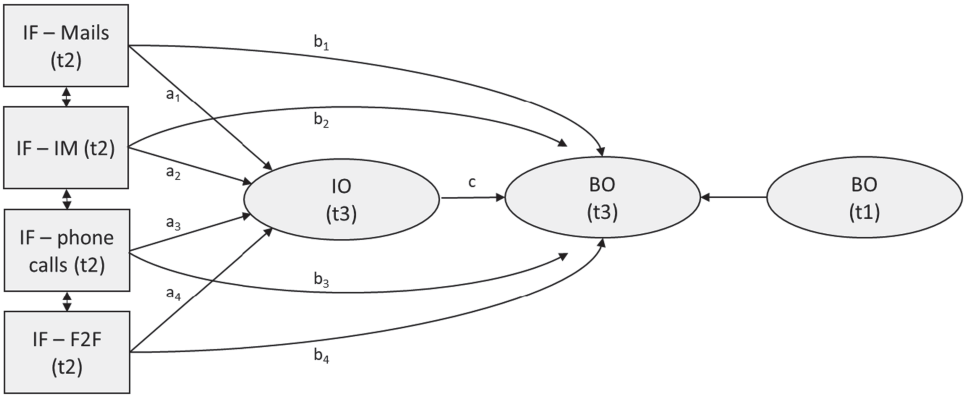


**Figure 1.** Graphical representation of the mediation model to answer RQ1 and RQ2. IF – Interruption frequency; IO – Perceived interruption overload, BO – Burnout Symptoms; Relationships are corrected for age and professional experience.

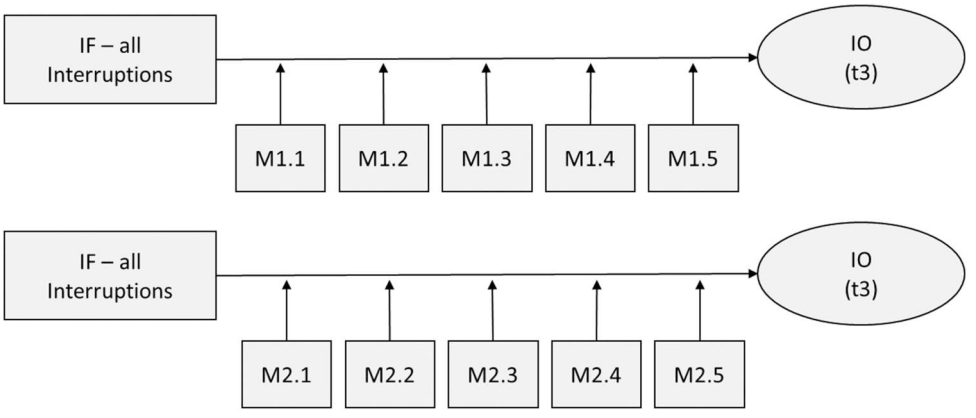


**Figure 2.** Graphical representation of the moderation models to answer RQ3 and RQ4, all moderatos related to the sender of the interruptions were tested in one separate model, all moderatos related to the content of the interruptions were tested in another separate model; IF – Interruption frequency; IO – Perceived interruption overload.

As described above, the present study adopts a combined event- and frequency-based approach by considering the relative frequency of the different interruption characteristics, as suggested by Puranik et al. (2020). In addition, such characteristics of interruptions may influence the impact of interruption frequency, which is why these characteristics need to be considered as moderators (Puranik et al., 2020). Therefore, to analyse the moderating influence of sender and content, two moderation models were calculated, one taking all senders into account the other taking the content into account. Both models were analysed with overall interruption frequency as a predictor and perceived interruption overload as a criterion. The moderators are described by the interaction of interruption frequency and the ratio of the numerical number of interruptions per sender and content in relation to the total number of interruptions per person. In this analysis, interaction effects were examined, while the analysis of main effects was omitted, as these aspects are not relevant to answering the research questions in the context of this study. To control for possible effects of confounding variables, both models were controlled for age and professional experience as described below (Figure 2) (for more information on sender and content Table 2).

## Results

On average, the participants stated that they were interrupted 25.52 times during their workday ($SD = 17.00$), of which 12.01 interruptions were due to emails ($SD = 15.94$), and another 4.16 interruptions were due to instant messages ($SD = 8.43$). The remaining interruptions were due to phone calls and personal contacts. In most cases, the interruptions included questions for the interrupted person ($M = 3.22$; $SD = 1.79$) or necessary and relevant information ($M = 2.97$; $SD = 1.10$) and were triggered by superiors ($M = 2.92$; $SD = 1.14$) (the coding follows the ISTA questionnaire: min. = never (1) and max. = several times per hour (6)) (Figure 3).

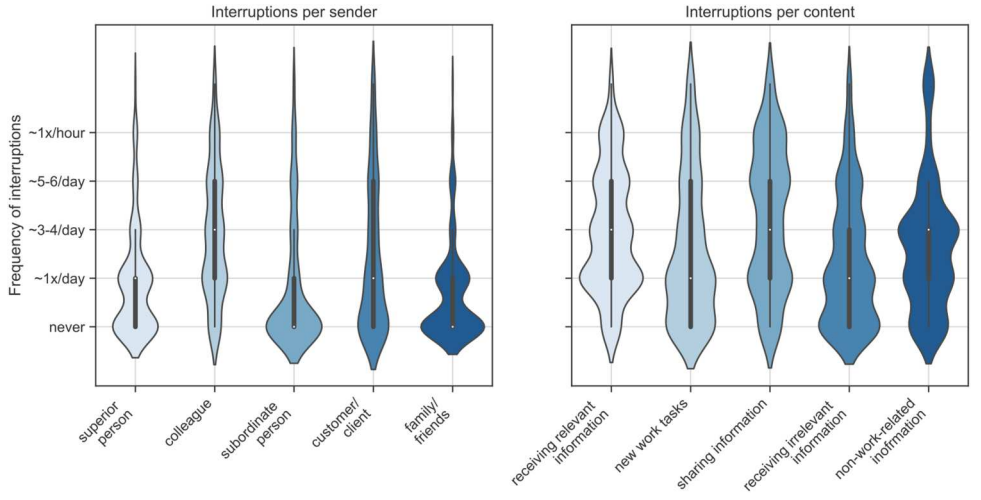


**Figure 3.** Graphical representation of interruptions by senders and content.

With regard to interruption overload and burnout symptoms, internal consistency of all scales was tested and showed good reliability with Cronbach's $\alpha. \geq .86$ for all scales. An overview of descriptive results is given in Table 3. In order to be able to carry out stable analyses, the prerequisite of linearity of the data, which is relevant due to the regression approach, was tested. For the other prerequisites (normal distribution and heteroscedasticity) robust measurement procedures were used. The relationship of all variables involved in the analyses was approximately linear, as assessed by visual inspection of the scatterplots after LOESS smoothing. Correlation analyses revealed that interruption frequency by emails and by instant messages are significantly positively correlated with perceived interruption overload, with the interruptions by emails having a stronger effect than interruptions by instant messages. In addition, both types of interruptions are significantly positively correlated with burnout symptoms, with a slightly stronger, although overall small effect for interruptions due to instant messages than for emails. Regarding the demographic and context variables, age is found to be significantly negatively correlated with perceived interruption overload ($p < .05$); furthermore, age and professional experience are both significantly negatively correlated with burnout symptoms at both measurement points in time ($p < .05$) (Table 3). Age and professional experience are therefore included as a covariate in further analyses. In contrast, neither the number of people working together in an office nor working from home correlates significantly with perceived interruption overload or burnout symptoms ($p > .05$), so these variables are not considered further as potentially confounding variables.

### *Mediating role of perceived interruption overload*

Structural equation modelling, including mediation analyses, was conducted to analyse whether the frequency of interruptions from emails, instant messages, phone calls, and F2F interactions predicted burnout symptoms and whether the direct path was mediated by perceived interruption overload. To control for possible effects of confounding variables, the model controlled for age and professional experience. In

**Table 3.** Mean, standard deviations, and Pearson correlation coefficient between study variables.

| | | *M* | *SD* | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | All Interruptions (t2) | 25.52 | 29.42 | .83** | .46** | .55** | .53** | .40** | .18** | .02 | .04 | .04 | −.04 | .11* |
| 2 | Interruption frequency (mail) (t2) | 12.01 | 15.94 | – | .24** | .32** | .22** | .32** | .15** | .19** | .05 | .05 | .04 | .10* |
| 3 | Interruption frequency (IM) (t2) | 4.16 | 8.43 | | – | .07 | .03 | .20** | .17** | .20* | −.11* | .06 | .10* | −.06 |
| 4 | Interruption frequency (calls) (t2) | 6.63 | 10.57 | | | – | .01 | .27** | .10** | .15** | .12* | −.03 | −.15** | .13** |
| 5 | Interruption frequency (F2F) (t2) | 1.88 | 11.86 | | | | – | .14** | .03 | .07 | −.03 | −.18 | −.13** | .05 |
| 6 | Interruption Overload (t3) | 2.10 | .98 | | | | | – | .46** | .60** | −.10* | .06 | −.04 | −.05 |
| 7 | Burnout Symptoms (t1) | 2.58 | .91 | | | | | | – | .67** | −.18** | −.07 | −.01 | −.13** |
| 8 | Burnout Symptoms (t3) | 2.63 | 1.14 | | | | | | | – | −.23** | .12** | −.02 | −.15** |
| 9 | Age | 43.80 | 11.98 | | | | | | | | – | −.06 | .07 | .52** |
| 10 | Office layout (persons per office) | 1.80 | .07 | | | | | | | | | – | .20** | −.03 |
| 11 | Time, working from Home | 3.28 | 2.05 | | | | | | | | | | – | .03 |
| 12 | Professional experience | 5.90 | 1.11 | | | | | | | | | | | – |

Note: $N = 492$, ***$p < .001$, **$p < .01$; Interruption Overload and Burnout symptoms were to be answered on a 5-point Likert scale ranging from *not at all* (1) to *fully agree* (5); professional experience were to be answered on a 7-point Likert scale ranging from *very low* (1) to *very high* (7).

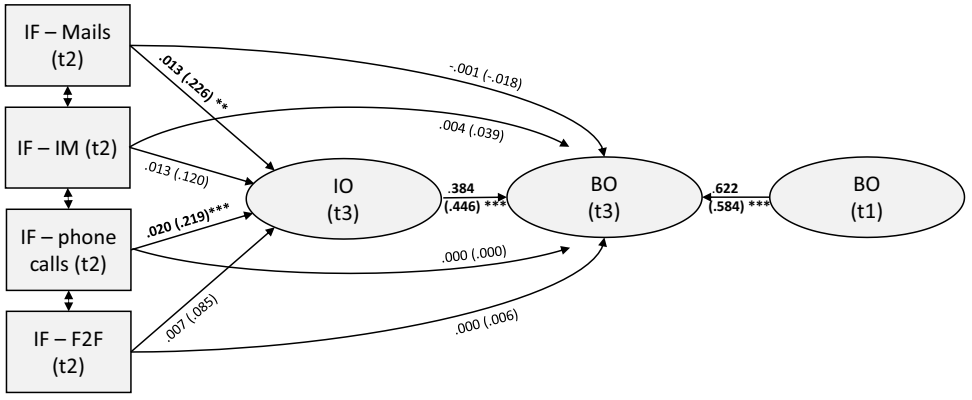


**Figure 4.** Path coefficients of structural equation model, including estimates and standardised estimates in brackets; significant codes: *$p < .05$, **$p < .01$, ***$p < .001$; IF – Interruption frequency; IO – Perceived interruption overload, BO – Burnout Symptoms. Relationships are corrected for age and professional experience.

addition, burnout symptoms at time t1 were included as a predictor of burnout symptoms at time t3.

First, the path coefficients are discussed. The evaluation of the path coefficients showed a strong significant positive relationship between perceived interruption overload and post-work burnout symptoms. In turn, perceived interruption overload was significantly positively predicted by frequency of interruptions from emails as well as frequency of interruptions from phone calls. In contrast, frequency of interruptions by instant messages as well as interruptions by F2F interactions did not predict perceived interruption overload. Furthermore, none of the predictors had a direct effect on employees' burnout symptoms at the end of the workday (Figure 4).

Consideration of the indirect effects shows that both the frequency of interruptions by e-mails and the frequency of interruptions by phone calls have a significant indirect effect on burnout symptoms via perceived interruption overload. Both indirect effects showed

**Table 4.** Mediating role of perceived interruption overload (IO) on the relationship of frequency of interruptions by different interruption types and burnout symptoms (BO).

| Predictor | Label | *b* | *β* | *p* | 95%-CI | c´ |
|---|---|---|---|---|---|---|
| Interruptions by E-Mails | $a_1 \cdot b_1$ | 0.005 | .101 | ** | [.034, .167] | .194** |
| | $c_1$ | −0.001 | .018 | .656 | [−.096, .060] | |
| | $c_1 + (a_1 \cdot b_1)$ | 0.384 | .442 | *** | [.343, 540] | |
| Interruptions by IM | $a_2 \cdot b_2$ | 0.005 | .054 | .126 | [−.014, .122] | .197** |
| | $c_2$ | 0.004 | .039 | .350 | [−.042, .120] | |
| | $c_2 + (a_2 \cdot b_2)$ | 0.384 | .451 | *** | [.351, .550] | |
| Interruptions by calls | $a_3 \cdot b_3$ | 0.008 | .089 | *** | [.045, .151] | .145** |
| | $c_3$ | 0.000 | .000 | .998 | [−.084, .084] | |
| | $c_3 + (a_3 \cdot b_3)$ | 0.385 | .446 | *** | [.348, .544] | |
| F2F Interruptions | $a_4 \cdot b_4$ | 0.003 | .038 | .697 | [−.153, .229] | .070 |
| | $c_4$ | 0.000 | .006 | .965 | [−.243, .254] | |
| | $c_4 + (a_4 \cdot b_4)$ | 0.384 | .446 | *** | [.349, .544] | |

Note: Indirect effect: a·b, Direct effect: c, Total effect: c + (a·b), c´: Correlation Coefficient, *b*: Unstandardised Estimate, *β*: Standardised Estimate; path labels are described in Figure 1; **$p < .01$; ***$p < .001$; Relationships are corrected for age and professional experience.

**Table 5.** Moderating role of the interruption sender.

| | | Estimates of moderation effect | | | | |
|---|---|---|---|---|---|---|
| Label | Moderator | *b* | *β* | *SE* | *p* | 95% CI |
| M1.1 | Higher hierarchical level | 0.001 | .305 | .069 | *** | [0.177, 0.433] |
| M1.2 | Same hierarchical level | 0.001 | .341 | .059 | *** | [0.223, 0.459] |
| M1.3 | Lower hierarchical level | 0.001 | .147 | .095 | .121 | [−0.039, 0.333] |
| M1.4 | External person | 0.000 | .134 | .078 | .087 | [−0.020, 0.288] |
| M1.5 | Private environment | 0.000 | .009 | .079 | .907 | [−0.145, 0.164] |

Note: *b* = Unstandardised Estimate, *β* = Standardised Estimate; ***$p < .001$; Relationships are corrected for age and professional experience.

complete mediation, i.e. the direct path between interruption frequency and burnout symptoms (t3) was not significant when the mediator was involved.

A comparison of the differences between the effect estimates revealed no statistically significant difference, either between the direct, indirect, or total effect estimates. An overview of these analyses can be found in FigShare, https://doi.org/10.6084/m9.figshare.24994679.v2. A summary of the direct and indirect effects can be found in Table 4. The fit indices indicate a relatively good model fit, following Hu and Bentler (1999), with RMSEA = .07 and CFI and TLI ≥ .90.

### *Moderating role of the interrupting sender*

Moderation analyses were conducted to determine whether the interaction between the frequency of interruptions and the proportion of interruptions by different senders significantly predicted perceived overload from interruptions. For these analyses, the frequency of all interruptions is used as a predictor. Moderators were calculated based on the proportion of interruptions from a particular sender in relation to overall

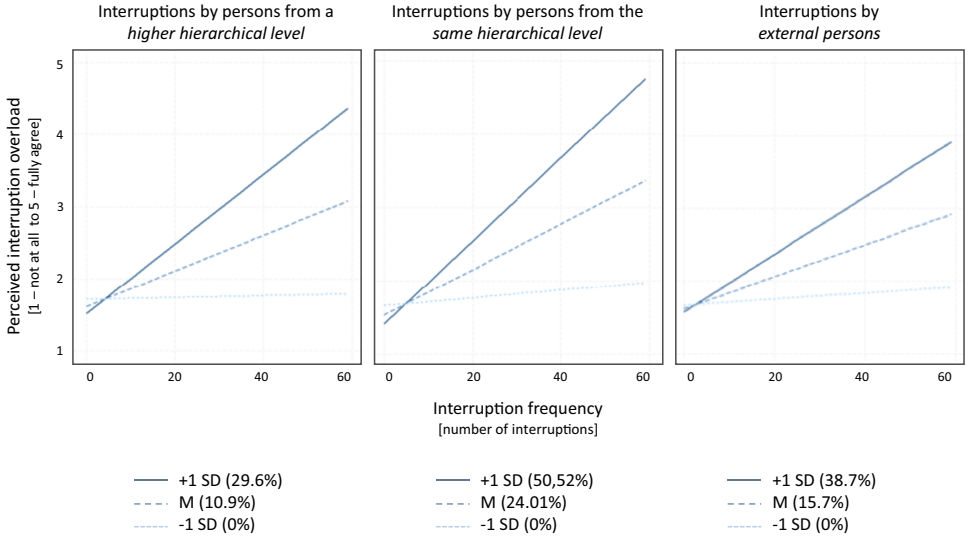


**Figure 5.** Graphical representation of the moderating effect of interruptions by supervisors, by colleagues and by external persons at a medium proportion of these interruptions (M), a low proportion (−1 *SD*), and a high proportion of these interruptions (+1 *SD*).

**Table 6.** Moderating role of the interruption content.

| | | Estimates of moderation effect | | | | |
|---|---|---|---|---|---|---|
| Label | Moderator | *b* | *β* | *SE* | *p* | 95% CI |
| M2.1 | Receiving work-related *relevant* information | 0.000 | .104 | .055 | .059 | [−0.004, 0.212] |
| M2.2 | New work tasks | 0.001 | .283 | .084 | ** | [0.118, 0.448] |
| M2.3 | Sharing work-related information | 0.001 | .356 | .058 | *** | [0.243, 0.469] |
| M2.4 | Receiving work-related *irrelevant* information | 0.001 | .246 | .078 | ** | [0.093, 0.399] |
| M2.5 | Non-work-related information | 0.001 | .065 | .066 | .329 | [−0.065, 0.195] |

interruption frequency. The results show that the proportion of interruptions from a specific sender can influence the effect of interruption frequency on perceived interruption overload. Specifically, the proportion of interruptions by persons from a higher hierarchical level (e.g. supervisors) and as well as the same hierarchical level (e.g. colleagues) and external persons positively moderate the relationship between interruption frequency and perceived interruption overload (Table 5). The fit indices of the model show a good model fit with RMSEA < .02 and CFI and TLI > .99 (Hu & Bentler, 1999).

Having a closer look at the simple slopes for the moderators, in all cases the positive moderating effect for high values (+1 *SD*) of the moderator was the strongest, it was weaker but still significant for medium values of the moderator (M), as well as for small values (−1 *SD*) of the moderators (Figure 5). The moderating influence of interruptions of the same hierarchy level shows the highest effect size ($\beta = .341$, 95% CI [0.223, 0.459]), however, what should be noted, is the ratio of these interruptions in the context of the total number of interruptions. The mean proportion of interruptions by higher hierarchical levels is just under 11% of all interruptions and thus already leads to significantly higher values of perceived interruption overload. In the case of interruptions by the same hierarchical level, a mean value of almost 25% is recorded, which thus corresponds to a proportion that is more than twice as high.

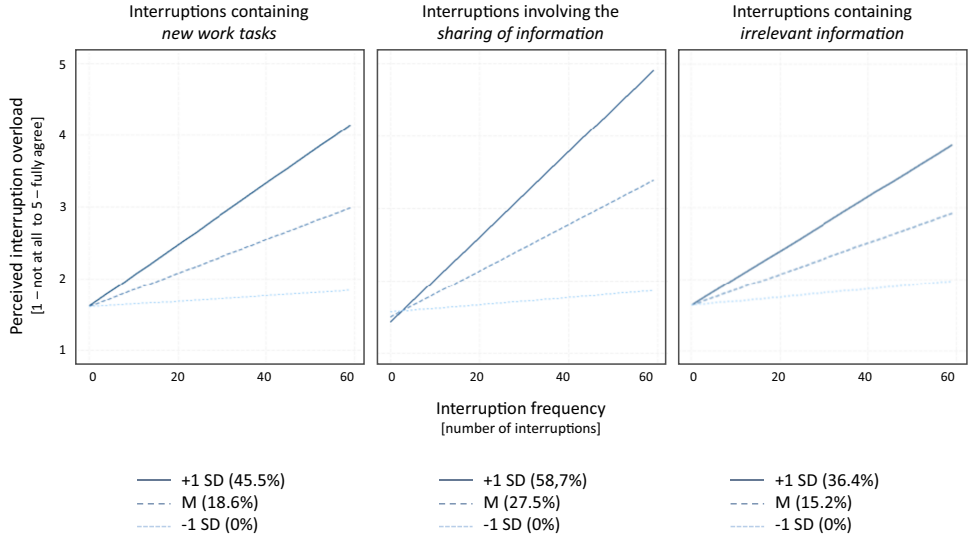


**Figure 6.** Graphical representation of the moderating effect of interruptions containing new work tasks, the sharing of information and containing irrelevant information at medium proportion of these interruptions (M), a low proportion (−1 *SD*), and a high proportion of these interruptions (+1 *SD*).

### *Moderating role of the interrupting content*

In addition, the content of the interruptions was examined for its moderating influence. Again, the frequency of all interruptions was used as a predictor and the calculation of moderators was based on the percentage of interruptions with a given content.

The results illustrate that the content of the interruptions also acts as a moderator: the proportion of interruptions containing new work tasks, the need for sharing information (i.e. getting questions) and the proportion of interruptions containing irrelevant information moderate the relationship between interruption frequency and perceived interruption overload. Following the standardised coefficients, the moderating effect of the proportion of interruptions containing the need for sharing information is having the strongest effect as shown in Table 6. The overall model reveals a good model fit with RMSEA = .02 and CFI and TLI $\geq$ .99 (Hu & Bentler, 1999).

Having a closer look at the simple slopes for the moderating variables, in all cases the positive moderating effect for high values (+ 1*SD*) of the moderator was the strongest, it was weaker but still significant for medium values of the moderator (M), as well as for small values (−1 *SD*) of the moderators (Figure 6).

## Discussion

Focusing on office workplaces, the present study aimed to answer the question of whether different characteristics of work interruptions have different effects on office workers in terms of their burnout symptoms. First, the mediating influence of interruption perception was analysed, examining interruptions caused by emails, instant messages, phone calls, and F2F interactions. In addition, the proportion of interruptions by different senders as well as with different content was examined for their moderating influence on the relationship between interruption frequency and perceived interruption overload. The objective was to find out whether different characteristics of an interruption can change their effects for the interrupted employee.

The first research question aimed to examine the relationship between interruption frequency and burnout symptoms, mediated by perceived interruption overload. Here, the various external sources of interruptions were analysed (emails, instant messages, phone calls and F2F interactions). Our results highlight that different types of interruptions are perceived differently by workers and thus indirectly have a different impact on perceived burnout symptoms at the end of the workday. Therefore, the findings of Ou and Davison (2011) can be supported with this study. The impact of interruptions due to short messages has neither a direct impact nor an indirect impact via perceived interruption overload on employees. Also, the previous findings on interruptions due to F2F interaction are supported by the results reported in this study. Like instant messages, F2F interruptions neither directly nor indirectly influence the employee burnout symptoms. Thus, the numerous findings on negative effects of interruptions can be attributed primarily to email-related interruptions as well as phone calls. The reasons for this can be manifold. On the one hand, the cognitive resources required to process the interruption may be relevant for its evaluation. For example, the form of instant messages can be an explanation, since they are generally shorter and more informally worded than emails and generally contain less information or less complex information (Rajendran et al.,

2019). Furthermore, employees feel more comfortable communicating with instant messaging applications (Pi et al., 2008). As a result, employees may feel less interrupted by instant messages, which may be why those interruptions do not significantly influence the perceived interruption overload. F2F interruptions, on the other hand, are characterised by personal interaction, can create a positive atmosphere, especially in the office context (Szóstek & Markopoulos, 2006) and furthermore, are often seen as relevant (Dabbish & Baker, 2003), and may lead the interrupted person to consider the interruption as time-worthy (Feldman & Greenway, 2021). These results highlight the relevance of investigating positive effects of work interruptions which have already been addressed in some previous studies (Feldman & Greenway, 2021; Meyer et al., 2021; Sonnentag et al., 2018). In the present study, positive effects were not investigated. Accordingly, no corresponding results can be analysed. However, clear differences between the types of work interruptions are discernible, which underlines that positive effects cannot be ruled out and therefore require further research.

While it has gone mostly unnoticed in previous studies, the present study has clearly demonstrated the relevance of individual perception. The individual evaluation of work interruptions appears to be of crucial importance when analysing the effects. This result can be considered decisive when it comes to identifying interventions and measures for long-term healthy working. Unlike workload, the construct of interruption overload relates to the cognitive resources required when the subject switches focus between tasks. In this respect, Kahneman's (1973) theory of divided attention may be useful to understand the mediation results. When concentrating on a task which is interrupted by an external stimulus, the person being interrupted will consciously or unconsciously turn his or her attention away from the primary task. Even if the decision is made not to pay attention to the interrupting stimulus, this decision is itself a shift of attention, which can cause an increase in cognitive load. The more the working person's focus is interrupted, the more time they must spend on "meta-work" or "overhead", the time required to organise and coordinate multiple tasks and domains (Tams et al., 2020). This explains why it is not the sheer number of work interruptions that influences the negative outcomes, but external resources (e.g. control over one's own work) and resources of the working person (e.g. prior knowledge) which influence the evaluation of work interruptions. In summary, both the first research question regarding the mediating influence of the interruption perception and the second research question regarding the differential influence of interruption types can be confirmed.

The third and fourth research questions examined the moderating influence of different senders and different content on the relationship of interruption frequency and perceived interruption overload. First, the moderating influence of the sender is discussed. Consistent with previous research, the proportion of interruptions by individuals of a higher hierarchical level (e.g. supervisors) appears to lead to more negative effects, in this case, higher perceived interruption overload. The higher the proportion of interruptions triggered by higher hierarchical levels, the higher the perceived interruption overload. As already analysed by Gupta et al. (2013) employees behave differently when interrupted by supervisors than when interrupted by colleagues. The authors found out that interruptions by supervisors are given more importance and take more time than interruptions by colleagues. In addition, workers were found to feel unable to defer work interruptions by supervisors compared to interruptions by others (Rennecker & Godwin, 2005). However, this is countered by the significant moderating effect of the

proportion of interruption of the same hierarchical level found in this study. Following our findings, also interruptions by persons from the same hierarchical level (e.g. colleagues) lead to a higher perceived interruption overload. However, the ratio of the interruption of the respective senders must be taken into account. The average number of interruptions by higher hierarchical levels (11%) leads to the same (negative) effects as the average number of interruptions by colleagues, which, however, are more than twice as high on average (25%). In summary, although both senders have a positive moderating influence and lead to significantly higher perceived interruption congestion, they differ in their contribution to the total number of interruptions.

The assumption that interruptions by external persons have more negative effects for the employee are confirmed with the results of this study. As already discussed, this is probably due to the different requirements. Although no clear results could be identified within the literature search, it seems likely that interruptions by external persons are perceived as particularly challenging due to their limited predictability and plannability and therefore make different demands than in the interaction with work colleagues. In contrast, the relevance of interruptions by family members during working hours was identified as a relevant stress factor (Du et al., 2018; Leroy et al., 2021), but could not be supported with this study. The present study was not conducted primarily among office workers who work from home, as was the case in the research of Leroy et al. (2021). Interruptions by family members are therefore likely to have played only a minor role. Also, this study did not include distractions, which may have altered the results, especially in the home environment. This discussion is also evident in the context of the content of the interruption; here, too, content from the private or family environment showed no influence on perceived interruption overload, which, according to Leroy et al. (2021), was not to be expected. Again, this can probably be explained by the fact that the study did not exclusively cover employees who work from home and therefore the effect was only slightly pronounced. In contrast, however, with new work tasks, sharing information as well as receiving irrelevant information are crucial. The latter can be related to the concept of information overload, describing the phenomenon of receiving more information than can be effectively processed, whereby amplification occurs due to a low information content or a complete lack of relevance for the recipient (Drössler et al., 2018). Interruptions that involve sharing information also have a moderating effect and positively influence the relationship between interruption frequency and perceived interruption overload. The results of Feldman and Greenway (2021) can provide an indication of the underlying processes. The authors were able to prove that the timing, the duration and the time worthiness of an interruption are relevant for the evaluation of an interruption by the interrupted person. If these characteristics do not apply, it can be assumed that questions from colleagues do not add value for the interrupted person and, in the case of a high frequency, thus lead to increasing stress. Further research on temporal aspects of interruptions could provide deeper insight here. Finally, the proportion of interruptions that contain new work tasks reinforces the relationship between interruption frequency and perceived interruption overload. Interruptions generally lead to a strong fragmentation of the workday, and new work tasks reinforce this. Fragmented workdays are not a new phenomenon; however, the extent to which short work episodes occur in the workday is new (Wajcman & Rose, 2011). While the actual interruption itself causes fragmentation, the

additional task causes further fragmentation, conditioning the simultaneous completion of multiple tasks and the feeling of time pressure, thus increasing cognitive strain at work.

### *Strengths and limitations*

The present study has some notable strengths, as it is based on a representative sample of the German labour force in terms of gender and age, and we were able to increase confidence in the directionality of the associations by controlling for the outcome variable. Furthermore, while the evidence is circumstantial, it also sheds some light on possible explanatory cognitive mechanisms regarding the effects of work interruptions. First of all, it is important to address the approach used to assess work interruptions. In this study, an event-based approach was used to collect data on work interruptions during the working day, as participants noted each time a certain type of event (in this case an interruption) occurred. However, the analysis focused on the frequency of these events, taking into account a frequency-based approach. A frequency-based approach, however, makes it difficult to study characteristics of the interruption as it is difficult to isolate the differential effects of individual characteristics. As discussed by Puranik et al. (2020), an event-based approach may help to study the attributes of the interruption by isolating these attributes. Therefore, in a next step, it is important to analyse the present findings using an event-based approach. This allows for a comprehensive examination of interruption characteristics and may provide further insight into the validity of the findings of this study.

Furthermore, the study examined only one occupational context and perspective of one country, which is necessary to better understand the impact within this sample, but generalisability of the findings to other countries and other occupational groups is limited. In addition, participants were free to choose the day of their participation, which may have affected the data, e.g. because participants may have chosen workdays with less expected work stress to participate in the study. The survey by means of online questionnaires has also limitations. Although the work interruptions can be investigated in a real context, this method requires the respondents to count and characterise their work interruptions independently, which may have led to errors, e.g. by overlooking or inadvertently increasing the number of interruptions counted. In addition, focusing on work interruptions may cause them to be perceived differently than they would be normally if attention were not drawn to them. Furthermore, the survey itself could be seen as a work interruption, even though the questionnaire was kept as short as possible.

Finally, it is important to acknowledge that this study addresses burnout symptoms, with a particular focus on the exhaustion dimension, while the other two dimensions (cynicism about one's work and reduced job efficiency) were not analysed. Consequently, the results should only be interpreted in the context of this particular dimension of burnout symptoms. In addition, it is important to stress that the results indicate varying degrees of burnout symptoms; however, it must be emphasised that the presence or absence of a burnout syndrome cannot be inferred from these findings.

## Conclusion and recommendations

In today's dynamic workplaces, work interruptions are common and unavoidable. Changes in the workplace, particularly through digitalisation, are increasing the

amount of computer work and with it the accompanying work interruptions. Therefore, this research focused on the investigation of work interruptions at such workplaces. The study revealed two main findings and present some practical implications: First the study underlines the importance of individual evaluation of work interruptions and that it is not the sheer number of work interruptions that matters, but the characteristics of the interruption. It is therefore crucial to look at work interruptions not only in terms of the possibility of reducing them, but also in terms of their nature and characteristics. This further suggests that it is crucial to sensitise and train employees on (digital) communication so that the use of such tools is not seen as a stressor due to work interruptions, but rather as a resource in the context of psychosocial demands in the work context. For research, the results mean that work-related interruptions cannot be examined purely on the basis of the frequency but must always be considered in relation to the resulting overload for the interrupted person, this means not only in terms of quantity but also in terms of quality. In addition, it makes sense to look at interruptions in a more differentiated way, based on their cause and content in line with Rigotti (2016).

Second, the results of the present study highlight that the type of interruption and, furthermore, the sender and the content can change the effects of the interruption. In practical application, on the one hand care should be taken to implement procedures that empower employees to use communication technologies in a healthy way (e.g. by switching off alerts or introducing silent work phases) and/or enable a healthy handling of interruptions from an organisational perspective (e.g. emails that are not time-critical are only sent at certain times, silent work phases). On the other hand, employees should be coached on the impact of their own interruptions on others. It is important to evaluate why a person should be interrupted, in which role this interruption will occur, in order to be able to decide how and, if necessary, when to initiate the interruption in order to avoid negative effects. Special attention should be paid to interruptions that do not contain directly relevant information for the interrupted employee. In this way, emails with general information should be sent in batches so that interruptions are reduced or, alternatively, a platform could be provided which collects such information, but the worker can access this information independently, thus eliminating the corresponding interruptions. Furthermore, when initiating interruptions, care should be taken to ensure that the content is clear in order to keep the cognitive resources to assess its relevance low. Moreover, the email inbox itself can be configured accordingly so that the relevant information is clearly displayed without having to read the entire email, as described by Jackson et al. (2003).

Overall, this study helps to reveal how and to what extent work interruptions affect employees – they cannot be evaluated solely with respect to their frequency, but must be classified in terms of their characteristics, which influence an individual's perception of them. The results offer valuable insights that will help to address further research questions, but also have practical implications for making digital work psychologically healthy in the long-term.

## Disclosure statement

No potential conflict of interest was reported by the author(s).

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