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THE EFFORT-REWARD-IMBALANCE AMONG PHD STUDENTS – A QUALITATIVE STUDY

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ABSTRACT

Aim/Purpose	The purpose of this paper is to examine the perceived efforts, rewards, motives, and coping strategies of a sample of PhD students in Germany based on tested stress models, the Effort-Reward-Imbalance Model and the Transactional Model of Stress and Coping.
Background	Pursuing a PhD can be challenging and stressful. Students face conflicts, isolation, and competition as well as difficulties with their supervisors. However, there is little known about how students perceive their PhD.
Methodology	Semi-structured interviews were conducted in 2021 with 21 male and female doctoral students from various fields of research. The recorded interviews were transcribed and analyzed according to Mayring's qualitative content analysis.
Contribution	Little is known about the work stress of PhD students. Most studies focus on single aspects (e.g., the relationship with the supervisor or the heavy workload) and use questionnaires that do not show all aspects causing work stress and how to prevent it. In this study, we examined the elements of work stress and coping strategies by using the Effort-Reward-Imbalance Model and the Transactional Model of Stress and Coping in a theoretical framework.
Findings	The analysis yielded two main categories for efforts and three main categories for rewards as well as several sub-categories. Participants persisted in the PhD program for five reasons: an intrinsic motivation, an interest in improving one's skills, the motivation to become an expert in one's field, the ability to contribute

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to research, and because of the flexibility and freedom offered during a PhD. Further, the study analyzed how PhD students cope with stress. Engaging in physical activities or spending time with family and friends were the most common coping strategies used, followed by work routines (like scheduling time for deep work and breaks) and seeking assistance from other PhD students.

Recommendations for Practitioners — To decrease the stress factors and negative health outcomes, we recommend incorporating personal as well as organizational measurements in the university setting. Through kick-off events and personal development workshops, PhD students should be made aware of the potential stress factors and coping strategies. Mentoring programs with postdocs can further support the doctoral students. On an organizational level, the knowledge about the elements of work stress should be incorporated in the recruiting process and supervisor workshops.

Recommendations for Researchers — As past research has investigated the effects of stress on physiological parameters, the framework of this study proposes the incorporation of the imbalance component into biological stress research.

Impact on Society — Understanding the efforts, rewards, and motives for a doctoral degree will help to reduce work stress of PhD students and create a more positive overall workplace, for example, by improving the relationship between students and their supervisors.

Future Research — Additional work is required to explore how the Effort-Reward-Imbalance model and coping strategies could interact and influence different outcomes. As the majority of the participants pursed a PhD degree in psychology, further studies need to be conducted that include other disciplines.

Keywords — coping strategies, effort-reward-imbalance, motives, PhD students

INTRODUCTION

Doctoral students play a key role in shaping the scientific landscape and its future (Vollmar, 2019). Demographic changes such as low birth rates, a growing ageing population, and an increasing number of PhD students as well as the skilled labor shortage could shape economic growth and technical innovations. However, high efforts and low rewards at the beginning of the scientific career, the doctoral phase, have been subject to criticism. For example, PhD students feel isolated (Grady et al., 2014; Tomasz & Denicolo, 2013). They attribute their mental health problems to career and financial insecurity (El-Ghoroury et al., 2012; Lau & Pretorius, 2019), work environment dilemmas (Pyhältö et al., 2012), or the supervisor's leadership style. Many of them turn to industry due to mental health issues (Levecque et al., 2017). Some even never finish their PhD. For example, the attrition rate in North America is estimated at 40-50 % and should be of high concern, as the PhD students already have a high level of qualification and a high amount of work spent in their theses (Litalien & Guay, 2015). According to Litalien and Guay (2015) the perceived competence, supervisor relationship, and interaction with other faculties can be seen as strong predictors for attrition. Also, in comparison to a normative population of the same age, PhD students report higher levels of depression, anxiety, and stress (Barry et al., 2018). This is in line with other studies that focus on the mental health of PhD students. They state that today's PhD students are generally more stressed than previous generations and have a greater risk of having or developing mental disorders, especially depression (Levecque et al., 2017). Thirty-two percent of Belgian science and social science PhD students where at a higher risk for developing a common psychiatric disorder. They experienced two (51 %) or four (32 %)

symptoms of poor mental health (Levecque et al., 2017). Compared to a random sample of a population with a similar level of higher education, the prevalence was twice as high (Levecque et al., 2017). Some studies report the highest incidences of mental illnesses in academic work settings compared to other occupations (Lau & Pretorius, 2019). This is problematic as stress affects dropout rates and the time to accomplish a PhD degree (Groenvynck et al., 2013; van der Haert et al., 2014). For example, one study showed that one third of the 724 participants intended to drop out (Castelló et al., 2017). Consequently, studies highlight the importance of understanding how stress affects the mental well-being of PhD students and the need for interventions to address mental illnesses (Evans et al., 2018; Lau, 2019; Lau & Pretorius, 2019). Earlier research mainly focused on demographic characteristics, financial situations (Fineisen, 2011), working conditions (Lange-Vester & Teiwes-Kügler, 2013), or dropout reasons (Hauss et al., 2012). Stressors of the day-to-day work of PhD students, however, have not yet been investigated. Therefore, it is important to examine work stress of PhD students with tested and valid stress models – the Effort-Reward-Imbalance Model (Siegrist, 1996) and the Transactional Model of Stress and Coping (Lazarus & Folkman, 1984). According to the first model, which focuses on work-related psychosocial stress, work stress can be defined as a result of a failed social reciprocity in terms of high efforts spent (e.g., high workload, working overtime) and low rewards given (e.g., job security, job promotion). This is in line with the definition of the International Labour Organization (2016, p. 2) which describes, work stress as a "harmful physical and emotional response caused by an imbalance between the perceived demands and the perceived resources and abilities of individuals to cope with those demands. Work-related stress is determined by work organization, work design, and labour relations and occurs when the demands of the job do not match or exceed the capabilities, recourses, or needs of the worker, or when the knowledge or abilities of an individual worker or group to cope are not matched with the expectations of the organizational culture of an enterprise." Nevertheless, there is no common standardizes instrument to measure work stress of PhD students. By using both models, the study will not only contribute to a deeper understanding of the relationship between efforts and rewards, but could also address illness (Waight & Giordano, 2018) by helping to identify coping strategies that PhD students can use to handle stress and a potential mismatch between high efforts and low rewards. Last, the study could indicate how to improve PhD work conditions and reduce the increasing world trend of doctoral students leaving academia (Chen, 2021) by pointing out job crafting measures (Creed et al., 2020).

LITERATURE REVIEW

PHD TRENDS IN GERMANY

In Germany, students face many challenges during their PhD. However, there is relatively little research on the situation of doctoral students and their health and well-being (Briedis et al., 2020; Schmidt & Hansson, 2018). The prevalence of mental health issues of doctoral students in Germany is alarmingly high "as 17.9% report moderate depressive symptoms and 62.7% show moderate to high state anxiety" (Max Planck Society, 2020, p. 32). Furthermore, the trend to leave academia in Germany is extremely high. Only 9% of PhD students at the largest scientific research organization in Germany want to pursue a postdoc position while the majority wants to leave academia for industry after their PhD (Degen, 2014). This may be due to fixed-term employment contracts that often end after less than one year in addition to low salaries. However, this is for PhD students working at a university. In Germany, there are a variety of options to gain a PhD degree (Federal Ministry of Education and Research, 2019). Students have the choice between an individual or structured PhD program as well as the opportunity to pursue a PhD in cooperation with a company. Due to this, there is variety of job positions (e.g., research associate at a department, in a third-party-funded project, or at a non-university research institution) and funding options (e.g., scholarship, individual funding). This study focuses on PhD students at universities as well as other PhD settings. It captures several elements that contribute to work stress while working on a PhD degree. Thus, this study draws on existing stress models.

THE EFFORT-REWARD-IMBALANCE MODEL

A well-known instrument to measure work stress is the Effort-Reward-Imbalance model (Siegrist, 1996). It is considered to be one of the most commonly tested and valid models of stress and has been used in several work-based and unpaid social contexts (e.g., household and family work). Furthermore, the Effort-Reward-Imbalance model has been applied in the academic context. Experiences of efforts and rewards of both students and predominantly teaching staff at universities have been investigated with Siegrist's framework (Hamilton, 2019; Williams et al., 2018), extending the applicability of the model to university-related settings. Based on the idea of social reciprocity, the model states that employees put efforts into their job in exchange for rewards provided by their companies, such as an appropriate salary (financial reward), job security or career opportunities (status-related reward), or esteem (socio-emotional reward). However, if individuals perceive an imbalance in the form of high efforts and low rewards, the expected reciprocity is not in place (see Figure 1). According to the Effort-Reward-Imbalance model, this can lead to strong negative emotions and physiological distress afflicting the individual's health and well-being (Siegrist, 2012). Also, studies have shown that an imbalance can increase risk for cardiovascular morbidity and mortality; high blood lipids, blood pressure, and blood coagulation or increase behavioral-related risk factors such as smoking (van Vegchel et al., 2005). In the academic sector, the Effort-Reward-Imbalance is a significant stressor contributing to burnout (Kim et al., 2017). Furthermore, Williams et al. (2018) found burnout to fully mediate the relationship between Effort-Reward-Imbalance and withdrawal intentions in Australian university students. Siegrist (2012) explains that a mismatch of high efforts and low rewards is sometimes maintained due to three motives: strategic reasons (e.g., career promotion), no alternative choices in the labor market (for unskilled, semi-skilled, or elderly employees), or a high need for approval often exhibited by excessive work-related overcommitted individuals. Those people invest more effort than required even if there is little to no reward (Siegrist, 2012.).

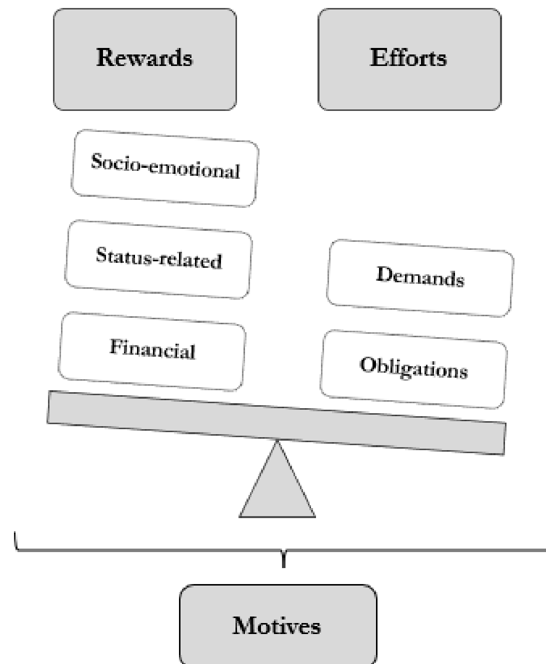

Figure 1. The Effort-Reward-Imbalance Model

In the long run, however, all three motives lead to higher levels of (emotional) exhaustion, fear, and depression as well as decreased recreation, sleep quality, job satisfaction, work performance, and

mental health status (Feuerhahn et al., 2012; Kinman, 2016). Therefore, we do not want to focus only on the efforts and rewards of doctoral students, but also on the motivational patterns of pursuing a PhD. Several motives have already been acknowledged, e.g., the quest for a personal/social achievement, an intellectual stimulation, the interest in professional/career development, or the interest in improving research skills (Leonard et al., 2005; Skakni, 2018). The motives may influence to what extent doctoral students control their PhD process (Grover, 2007). Personally and professionally motivated PhD students, for example, are more likely to persist in a doctoral program (Hoskins & Goldberg, 2005). Highly motivated individuals tend to be more committed (Georgellis et al., 2001) and engaged at work (Van Beek et al., 2012). This can also be understood as a health-adverse coping pattern in which employees feel obligated to work more than required by their employment contract (Montano & Peter, 2021; Siegrist, 1996). Therefore, our research also focuses on coping patterns that might moderate the perceived lack of reciprocity and health outcomes (Kim et al., 2017). Interestingly, coping patterns may not only buffer the negative effect of academic stressors on health outcomes, but also strengthen it. Schmidt and Hansson (2018) even consider that some coping strategies might have a dual function, such as the relationship with supervisors and the scholarly community. On the one hand, the relation could be part of a support system. On the other hand, it could be a stressor due to conflicts and high expectations. Therefore, it is important to analyze how PhD students perceive stress factors during their doctoral studies.

The Transactional Model of Stress and Coping

A common model to analyze how people perceive and cope with stress is the Transactional Model of Stress and Coping (Lazarus & Folkman, 1984). This model shows that individuals master, tolerate, or reduce internal and external stress factors by evaluating the situation (primary cognitive appraisal) and assessing available coping resources (secondary cognitive appraisal). In general, there are two different coping mechanisms called problem-focused and emotion-focused coping (see Figure 2). According to these strategies, individuals either react on stress factors by managing and solving a problem actively or mitigate unpleasant situations by regulating their emotions and distress.

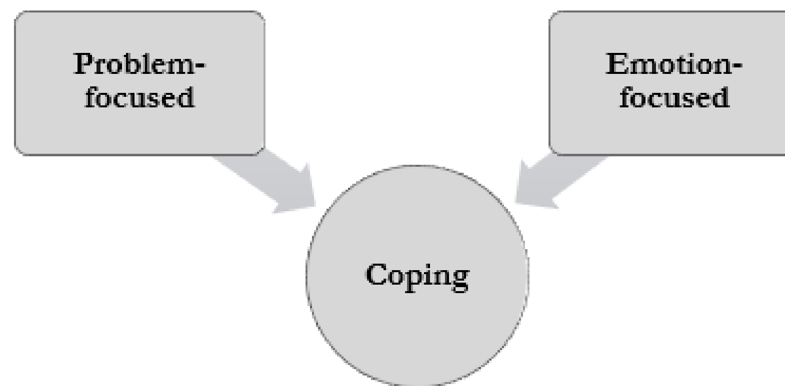

Figure 2. The Transactional Model of Stress and Coping

Both problem- and emotion-focused coping strategies have already been found in students pursuing a doctoral degree, e.g., (1) planning (Martinez et al., 2013) and receiving funding (McAlpine & Norton, 2006) as problem-focused coping strategies and (2) social support (Smith et al., 2006), activities with friends (Byers et al., 2014), doing exercise, crying, or isolating as emotion-focused coping (Martinez et al., 2013). It should be considered that some of the emotion-focused coping strategies can also be self-handicapping for PhD students (Kearns et al., 2008). Typical examples mentioned by the authors are behaviors, such as overcommitment, procrastination, or perfectionism. Therefore, it is important to investigate which coping strategies are commonly used among PhD students and to

identify those that lead to self-sabotaging behaviors. This could help to identify and take countermeasures against self-handicapping coping strategies that might moderate the lack of reciprocity between efforts and rewards. Lau (2019) stated that the model helped him to analyze his own stress reaction and self-handicapping coping strategies during his PhD. As the author only reported about his coping experiences, we want to broaden this view. We apply the Transactional Model of Stress and Coping by looking at coping strategies of a variety of PhD students.

THE CONCEPTUAL FRAMEWORK OF THE STUDY

This study aimed to apply the Effort-Reward-Imbalance model (Siegrist, 1996) and the Transactional Model of Stress and Coping (Lazarus & Folkman, 1984) as theoretical frameworks to explore the perceived efforts, rewards, motives, and coping strategies of a sample of PhD students in Germany. By considering both the models, the study focuses on stress factors and motives of PhD students as well as on coping strategies. Figure 3 shows the most important elements of each model that we considered for our investigation.

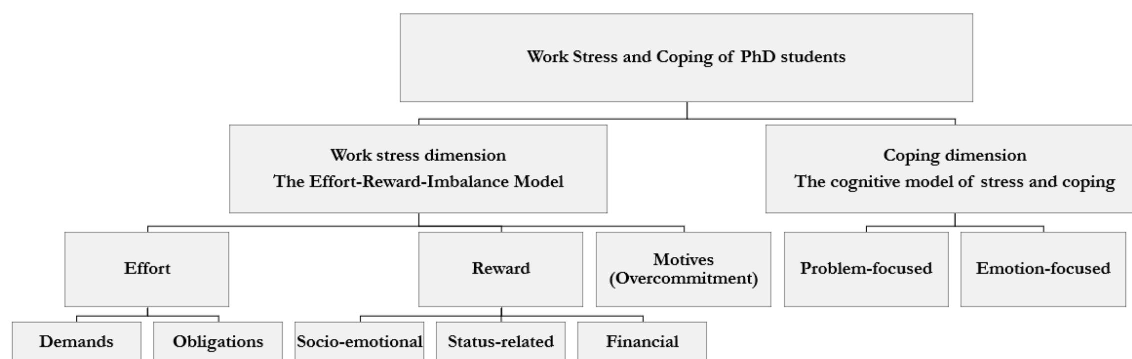

Figure 3. The conceptual framework of the current study

As there are only few studies that focus on university students (Hilger-Kolb et al., 2018; Hodge et al., 2019; Portoghese et al., 2019; Wege et al., 2017) or academic staff (Kinman, 2016) while using the Effort-Reward-Imbalance questionnaire, we decided to follow a qualitative approach. This offers the opportunity to gain an in-depth understanding of the circumstances of PhD students and to understand which elements of the models apply to PhD students. This allows us to be able to understand the relationship and consequences of efforts. Furthermore, the investigation can help to address illnesses by indicating a variety of practical implications and countermeasures against the increasing worldwide trend to leave academia. To address our study objectives, we proposed the following research questions:

1) Why do PhD students pursue a doctoral degree?
2) What efforts and rewards do PhD students perceive during their doctoral training in Germany?
3) How do PhD students cope with stress related to their doctoral education?

METHOD

The study presents analyses of qualitative data from semi-structured interviews with 21 PhD students from seven universities in Germany. Interviews were carried out from September to October 2021. The qualitative approach was chosen to gain explorative and deep insights into PhD students' efforts, rewards, motives, and approaches to cope with a potential mismatch between efforts and rewards. This allowed us to describe a complex social phenomenon from the perspective of the people affected (Malterud, 2011). Also Mayring's (2003) qualitative content analysis offers important features

for our research as it is a well-validated, systematic, and rule-based process. Compared to other content analysis it allows the examination of deeper, underlying latent context of a text (Cho & Lee, 2014). Furthermore, it offers the opportunity to combine deductive and inductive approaches, allowing one to consider theoretical models during conceptualization as well as to discover new themes emerging from the data (Cho & Lee, 2014.). Also, the method helps to focus on the relevant aspects of the research questions (Cho & Lee, 2014.). Therefore, we chose Mayring's qualitative content analysis.

Participants

Participants included PhD students pursuing a doctoral degree at German universities. To get a broad view about different efforts, rewards, motives, and coping strategies of PhD students we included male and female students from various fields of studies with different financial backgrounds (e.g., scholarship, employment at university or company) and stages into their PhD. Specific selection criteria were the enrollment as a doctoral student and the ability to speak either German or English.

To recruit the PhD students, we sent an email to different organizers of scientific colloquia from the two biggest universities in Bavaria, briefly informing them about our study and asking them to forward the participation request to their PhD students. The request included information about the study and the available interview appointments. Those who agreed to participate were invited for an online interview via Zoom. The objective of this sampling strategy was to recruit PhD students who represented a broad spectrum of experiences and perceptions (Malterud, 2011). Additional recruitment was conducted by snowball sampling, i.e., participants were verbally encouraged to forward the interview invitation to their friends and colleagues after the interview. This sampling method was used to increase the number of participants and to collect a broad dataset (Noy, 2008). Overall, 21 PhD students from seven different universities took part in our interviews. Data collection was completed following the principal of saturation, defined as the point where no new themes emerged (Kaiser & Hennink, 2020).

Data Collection

A semi-structured interview guideline was developed based on the theoretical framework of the Effort-Reward-Imbalance components: efforts, rewards, and motives (see Appendix A). As we also investigated how PhD students coped with stress, we added an interview section asking about coping strategies based on the Transactional Model of Stress and Coping. Further questions, such as warm-up and follow-up questions, were also asked during the interview. A pilot test of the interview guideline was carried out with two PhD students, who were distantly known to the interviewer. They did not have any insight in the research project before the interview. The criteria used to choose participants for inclusion in the pilot study were similar to those used for the sample selection. The pilot allowed us to make slight adjustments to the interview questions and their order. As we only made small adjustments and the first two interviews comprised relevant information, they were included in the analysis.

Trustworthiness

To assess the rigor of this study, we followed the four standards of qualitative research, known as credibility, transferability, dependability, and confirmability (Lincoln & Guba, 1985). Credibility was achieved through data, investigator, method, and theoretical triangulation (Korstjens & Moser, 2018). We made sure to gather our interview from PhD students with a variety of PhD settings (e.g., external students, scholarship holders, university students) and with different characteristics (e.g., PhD year, financing). Furthermore, the interviews were coded, analyzed, and interpreted individually by the first and second authors to acknowledge and reduce biases (credibility). After both authors coded the interviews separately, the authors discussed their coding schemes until they reached agreement. The first author updated the codes used in the interviews accordingly. Theoretical triangulation was

achieved by adding two theories into our conceptual framework. Transferability was established trough an in-depth description of the data (e.g., quotes, interview guide, study framework) that ensures that the findings can be transferred to other settings or groups. Additionally, the study implemented several elements that contribute to dependability (Miles & Huberman, 1994), for example, a study design with clear research questions and the specification of the theoretical constructs and analytical framework.

Procedure

The interviews were mainly conducted in German. International PhD students (*n* = 2) were allowed to switch to English if necessary. The first author of this study pseudonymized and transcribed each interview. Furthermore, direct quotes used in this paper were back and forth translated into English by the first and second author of the study (Brislin et al., 1973). The last three authors of the paper knew the participants by only their initials. Before starting the interview, the interviewees gave written informed consent and had the chance to ask questions. An interview lasted for approximately 45 minutes, with the length of interviews ranging from 25 to 85 minutes. This was mainly caused due to the variation in richness of description by the interviewees. Interviews were recorded via video conferencing. During the interviews neither the participants nor the interviewer perceived technical issues, and all participants where familiar with using an online conferencing tool. As we did conduct the interviewees only online and not face-to-face it is not clear if rapport would have been different if face-to-face. Also, it is not clear, if the results would have been different if audio-only recording would have been used. However, we believe that the interview situation was quite natural to the interviewees, as they were used to the situation due to Covid-19. Short field notes were taken during and after the interviews.

Data Analysis

In the first step, the audio recordings were transcribed verbatim in German and subsequently anonymized to protect the participants' identity and ensure confidentiality. Secondly, the data analysis was carried out in a deductive-inductive process according to Mayring's (2003) qualitative content analysis by the first and second author. They started with one interview to test-code the established coding categories that were retrieved from the initial coding scheme (see Figure 4). Then the authors added new categories as new themes and sub-themes emerged from the analysis of different interviews. Disagreements on the sub-categories were thoroughly discussed until consensus was reached and the coding system was slightly revised. The discussions helped to reduce personal involvement and preconceptions on the interpretation of the results. Also the authors picked typical statements for each result section and translated them to English (Brislin et al., 1973). The software MAXQDA (2018) was used for the analysis. The final coding system can be found in the Appendix C.

Results

Following the theoretical framework, the data was categorized into efforts, rewards, motives, and coping strategies. Further themes emerged during the data analysis. Figure 4 illustrates the main themes. The result section gives an overview of the main themes, including sub-themes, and are supported by illustrating quotations.

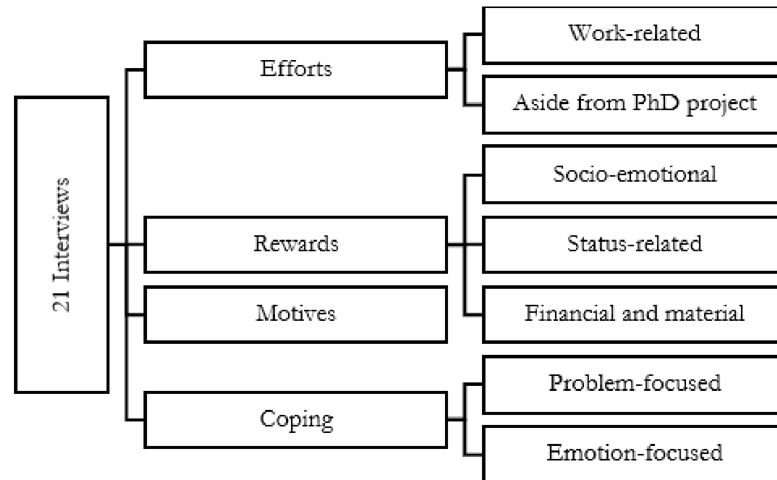

Figure 4. Main themes of the study

Participant Characteristics

Table 1 gives an overview of the socio-demographic characteristics of the participants.

Table 1. Socio-demographic characteristics of participants

Gender	female	14
	male	7
Age	25-29	15
	30-34	5
	> 35	1
PhD duration in years	< 1	5
	1	4
	2	5
	3	5
	4	2
Study field	Psychology	12
	Neuroscience	1
	Physics	2
	Law	1
	Management	2
	History	1
	Business Information	1
	Engineering	1
Main funding source	Job at university	7
	Scholarship	6
	Job at research organization	1
	Job at company (external PhD)	7

EFFORTS

Respondents named several efforts they made during their PhD. The major ones comprised work-related efforts that were caused by the nature or the scientific approach of the PhD project as well as efforts aside from the actual PhD project. The nature of a project describes the structure of the program. It includes typical characteristics of this process as well as its implication for the individual student (e.g., long-term project, mainly individual tasks). The second category includes all information about the scientific work methods of the PhD project and its effects on work stress of PhD students (e.g., topic research, method selection). Efforts aside from the PhD project comprise efforts that were not directly linked to the thesis and rather arose from the position as a PhD student, such as preparing lessons and teaching. All categories are described in detail in the following section.

Work-related efforts

While working on a PhD project, students made a variety of efforts. Some of these efforts were caused by the nature of the project. The project is often set up as a long-term project with little or no external structure nor exchange with colleagues and other PhD students. Students worked on their project for years until results became visible. This went along with psychological stress, such as feelings of social isolation, loneliness, and a lack of inspiration as well as motivation problems.

Due to little external structure (e.g., fixed working hours, regular holidays), some students had trouble with detaching from work, especially while working from home and with personal digital devices, such as laptops and phones. Furthermore, students struggled to structure their workday and project and feared that their time management was not realistic and that they would take longer than predicted to finish their PhD. This was especially stressful for students with fixed-term financial support and for those who just started their doctoral program. After directions were set, the uncertainty about the limited amount of time became less. Furthermore, PhD students mentioned uncertainty about the PhD process and their own performance and skills as well as their future job prospective (see Appendix B). Notably, the most common uncertainty mentioned was financial uncertainty. It was often connected to uncertainty about the future and job insecurity. Representative quotes on the work-related efforts due to the nature of the project can be found in Table 2 (left column).

Other efforts were caused by the scientific approach of the project, such as finding and narrowing down the topic, reviewing the literature, choosing a scientific method, writing, presenting, and publishing results (quotes from the interviews can be found in the right column of Table 2). The interviewees characterized the first elements of the scientific methodologies and technologies as typical tasks (e.g., reviewing literature), while the last steps were described as high stress factors (e.g., feedback and publication process). Especially the peer-review process was seen as time-consuming, straight forward, and sometimes even toxic. Regarding the feedback of supervisors, the interviewees often had to wait long periods and struggled to incorporate the feedback of professors as the expectations were too high, too far away from the project, or ambivalent. It was also reported that some professors did not have any time for questions or giving feedback. Both waiting for a long-time or not receiving any feedback caused stress. Besides, we recognized a general unclearness about the supervisory relationship by PhD students who just started their PhD training.

Table 2. Sample quotations about work-related efforts

Nature of the project	Scientific approach of the project
"Even if you have a team, somehow you work for yourself. So, at the end of the day, you sit alone in front of your laptop and write a paper. Of course, you can exchange ideas about it, but at the end of the day you are a lone fighter." *"The truth is that I sometimes still have problems structuring myself because it depends 100% on myself. There is very little external structure that arises, for example by meetings or teamwork that give a certain structure."* *"The PhD does not produce daily results …., so there are definitely days where you ask yourself at the end of the day: `Man, what did I actually do today?' You have nothing tangible and presentable, although you may have invested time all day. An instant gratification does not take place, so you may have to lay out your motivation strategies in a less output-oriented manner."*	*"What I thought was exhausting and stressful is the specific topic search, with the specific content and theories. I had imagined it to be easier."* *"I perceived the beginning most stressful, so the first 3-4 months because there was no clear and specific topic … getting an overview is not that easy."* *"And then … there is a certain pressure in science to publish with a very high-ranking …, but the whole review process takes time, sometimes months. I find that really exhausting."* *"This whole academic culture is rather toxic, compared to corporate cultures I know. So, the feedback in peer review journals is not friendly, very direct, and perhaps somehow toxic … most of the time it has hardly anything to do with the quality of your work, but the general academic culture has been shaped that way."*

Efforts aside from the PhD project

Almost every interviewee named non-work-related and work-related responsibilities besides working on their thesis. On a non-work-related level, stress was mainly caused by social obligations, finding time for leisure activities, household responsibilities, and dealing with a relocation. On a work-related level, all students had to actively engage in networking (e.g., looking for a project partner, attending conferences) or handle it in the background of their PhD project (e.g., career planning). All other work-related responsibilities that caused stress and limited the time available for the actual PhD thesis varied between different PhD students, e.g., PhD students working at the university vs. PhD students working in the industry.

PhD students who worked at the university described tasks that were not directly related to their own PhD project as further efforts. Interviewees mentioned that it was expected of them to give feedback to colleagues or to collaborate on papers. Supervising undergraduate and master theses or teaching was also part of their obligations. While some of our interviewees described teaching as a further time-consuming task with low rewards, others associated teaching with fun and a high personal value. Furthermore, some students were required to participate in different extracurricular formats, e.g., research colloquium, paper club, and lectures of graduate schools (see Table 3, left column, for representative quotes).

PhD students receiving a scholarship named the application process, the interim reports, and the attendance of seminars as main efforts outside of their PhD project. While writing a report on the progress of the PhD project was mandatory, the attendance of social and educational events was voluntary. Still, PhD students felt obligated to attend events and seminars of the scholarship holder. Besides those obligations, volunteer work and own projects increased the workload. Students who worked at the university in addition to their scholarship further faced the efforts mentioned above. Table 3 (middle column) gives example of non-thesis related efforts from students holding scholarships.

External PhD students who worked in part-time jobs outside of academia faced difficulties balancing the time between the PhD project, job-related work, and switching off properly during leisure times. Furthermore, some of the PhD students struggled with networking and exchanging experiences with their fellow PhD students because they had little to no contact with their institute. If the doctoral degree was pursued during a sabbatical, further barriers such as staying in contact with colleagues or the pressure to finish the PhD project in the given and funded time were added to the efforts of working on the thesis (see Table 3, right column).

Table 3. Sample quotations about the mentioned work efforts besides the PhD project

University PhD students	Scholarship holders	External PhD students
"In the first semester I spent one of five working days a week correcting homework, preparing seminars, and giving group exercises. That takes up a lot of time." *"There are also formats at our department … that I find very exciting, but they create additional work. For example, we have a paper club were we regularly read and discuss papers. That does not necessarily have anything to do with my own dissertation."*	*"Applying for the scholarship was an enormous amount of work …, but it has paid off in the long run."* *"One further obligation … is to write a detailed report on my work … once a year. It doesn't take up much of my work, of course, but it was only due a few weeks ago, so I'm thinking about it."* *"I have started my own project at the foundation, which of course costs quite time and to a certain extent it is also an obligation, that I have chosen myself. … It clearly takes time off the thesis, but I can live with it."*	*"In order to be able to earn a little extra living, I work for a company once a week. That means that there is an obligation outside of my PhD project … and then you have other obligations, such as maintaining contact with other employees, so that you are still connected to the company."* *"I don't have a great network in the institute because I'm not part of a project or employed at the university. That was my personal decision, but as a result, I have a smaller network, which is required when it comes to career planning."*

Rewards

In accordance with the Effort-Reward-Imbalance model, we focused on status-related, socio-emotional, and financial rewards in our interview questions (see Figure 4). Findings are reported below.

Socio-emotional rewards

Participants distinguished between personal and professional environments when asked about socio-emotional rewards. On a personal level, PhD students with an academic family background reported that their family perceived their PhD as a "normal" career path. Most of them received a lot of emotional support and appreciation from their family and friends. Some students were supported by other PhD students or scientists from similar research fields in their personal environment. PhD students without an academic background reported different reactions. Some received high respect and appreciation for pursuing a PhD degree while others had to deal with critical questions, such as "When are you going to start a real job?" They also reported that some family members struggled to understand the characteristics of a PhD degree. Independent of their family background, PhD students wished for the support of their families. They expressed that they were not only looking for interest, but also encouragement and emotional support whenever they faced conflicts, tensions, or doubts during their PhD. Table 4 shows sample statements of how a PhD degree is perceived by family and friends from different educational backgrounds.

Table 4. Sample quotations of socio-emotional rewards

Academic background	Non-academic background
"Most of my friends are also PhD students, so they know how it works and so on. So there is appreciation, but not too little or too much." *"I don't think it's very special that I am doing a PhD … because my family has done it as well."*	*"The appreciation from my family is very abstract. They don't have any idea what studying and doing a PhD means, but on an abstract level they are very proud because they know that it is something great."* *"My family was really happy when I told them about my PhD plans. They started to call me doctor and I was like 'Folks, stop it, I'm not a doctor, I don't want to be called like that'. So, they show me high respect."*

On a professional level, PhD students received support from supervisors, colleagues, and other PhD students at different occasions, such as group seminars, colloquia, or (team) meetings. PhD students described the exchange with other doctoral students as very open, collaborative, productive, or supportive. The PhD candidates often had similar feelings, experiences, and problems. During the exchange, they got new insights, ideas, created problem-solving strategies, and felt connected to each other.

Furthermore, the socio-emotional reward from supervisors had a great influence on the PhD students. The feedback from supervisors was often described as extremely valuable, helpful, and encouraging. One person even implied that the positive feedback would impact their performance. Feedback from postdoc supervisors was often described as work-related, very precise, and helpful to answer specific questions. It also provided guidelines and helped to prioritize tasks. Professors rather gave feedback on a meta-level (see Table 5). Some PhD students mentioned that they were surprised how positive the feedback from their supervisors was, especially if things did not go well or when they would have judged their own work worse. Moreover, some PhD students who reported getting regular feedback described themselves as lucky because they had the feeling that their peers got less feedback and appreciation. Other interviewees, however, assumed that all PhD students receive equal feedback independent of their workload or PhD setting (e.g., internal or external).

Besides the recognition of their own work by supervisors, interviewees also appreciated the recognition during the publishing process – especially those who received little to no feedback from their supervisors. The reviews encouraged some of the participants and helped them to get new insights into their topic. Nevertheless, there were also critical voices about the long-time span from writing the paper until it was published. The recognition itself was also criticized as it is non-materialistic (e.g., verbal or in the form of quotations) instead of a salary increase.

Another reward, that was often mentioned, was freedom throughout the PhD. The interviewees referred to different types of freedom: (financial) freedom due to a scholarship, freedom in time management and workplaces, freedom to do own projects and to decide what to work on. The latter, however, was also a perceived as a stressor because participants missed guidance and had trouble motivating themselves.

Additionally, PhD students with a scholarship mentioned the non-material support offered by their scholarship as a socio-emotional reward. They felt like scholarship events (e.g., seminars, weekend getaways, meetings with tutors) helped them to build up new motivation, get new insights, and broaden their views. Table 5 summarizes sample quotes of socio-emotional rewards from the professional environment.

Table 5. Sample quotations of socio-emotional rewards on a professional level

PhD students	Supervisors	Scholarship holders
"It is also helpful if you talk to other PhD students about how you are doing. Everyone can for example relate if you had to throw everything over again … and that's kind of supportive when you know: 'Ok, I'm not the only one who is desperate about it and better times will come again'." *"I would say the most valuable thing is the exchange between the doctoral students. We have such an open, collaborative and productive relationship with one another … You would need a lot more time if you had to make every mistake by yourself, whereas now, we have a few people who have a lot of experience. It often happens that others have already had the problem. … That is definitely very valuable."*	*"My supervisor always adds interesting ideas. He always sees the bigger picture and puts my work into a larger framework. He also tries to elaborate the practical relevance. … It is therefore a good addition to the feedback from my postdoc supervisor. He gives me feedback on a more specific level."* *"I really have the feeling that I am supported and that they also push me. … I also see my supervisor as a role model and have the feeling … that I am actually being addressed individually."*	*"Umm then, of course, from the scholarship holder financially and ideally, which also makes a big difference."* *"So financially, of course, through my scholarship holder, but also ideally. It is part of the scholarship to support their students with seminars. They were incredibly enriching. … You get fresh input, which has nothing to do with your topic. … Then you go back to your dissertation and say 'Hey, I had such an enriching and cool weekend, now I'm back to deal with my dissertation."*

Status-related rewards

The Effort-Reward-Imbalance model states that status-related rewards can be divided into three different sub-categories: job security, career promotion, and professional development opportunities (Siegrist, 1996). Following this approach, we analyzed our interviews.

Participants had different opinions about the job security at the university. Some criticized the system heavily as many postdoc positions only offered fixed-term contracts. They stated that career paths are very strict and positions are rare due to the great difference between vacancies and demand. This uncertainty and the necessity of mobility were perceived as burdensome, especially regarding starting a family and staying in touch with the personal environment. Others worried less about job security, although they acknowledged that the situation was leaving something to be desired. Yet when professorship or a permanent contract was reached, the interviewees rated the job security as quite good (see Table 6, left column).

Opportunities for career promotion were described as not adequate, slow, complicated, difficult, very limited, rather bad, or awful, especially if participants related to a professorship or compared the career promotion opportunities with the industry. Most of them saw better career opportunities outside of academia and were less attracted by the career track at the university due to different reasons. For example, the interviewees were unsatisfied with the temporary employment, the academic fixed-time contract act, scarce funds, and the mobility required in academia. They argued that those conditions would lead to uncertainty, pressure, and competition between researchers. One participant even felt that the uncertain job and financial situation robs their energy. Overall, most of the participants asked for a change in terms of job security and career promotion at German universities. They refereed to how other countries handle the job security of academic employees. Table 6 (middle column) contains quotes regarding career promotion.

The professional development opportunities were described from unsatisfactory to quite good. Most of the participants mentioned that they learned a lot during their PhD, including personal and professional skills (see Table 6, right column). Especially working in an interdisciplinary environment, attending conferences and seminars, and the variety of PhD tasks were mentioned as development opportunities, although they were also recognized as additional burdens.

Table 6. Sample quotations for status-related reward

Job security	Career promotion	Development opportunities
"I know that oftentimes, one gets fixed-term or part-time contracts. So, I'd say that if one wants to do research … there isn't a lot of appreciation, regarding job security or career promotion." *"It's a requirement to be extremely flexible in terms of location that is not compatible if I, as a woman, for example, want to have a child because then, you are not that flexible."*	*"I do not think that the career opportunities are good or adequate."* *"There are opportunities for career promotion, but they are actually rather bad."* *"I find the career opportunities very slow and complicated."* *"The opportunities for career promotion are awful. … The pyramid is very narrow. As soon as you have a certain residence preference, a professor has to retire before you can get it."*	*"I see a few development opportunities by attending courses during the PhD and being able to attend interdisciplinary courses. And I also think that the conferences … are opportunities for personal development, not only regarding your research project, but also when it comes to presenting yourself, your own content. …. I see all that as great development opportunities."*

Financial and material rewards

Many interviewees stated that their wage was not enough, dissatisfying, or not fair compared to jobs outside of academia and in relation to their workload. Furthermore, PhD students criticized that they cannot make any savings with their salary.

The interviewees mentioned that they were conscious about the low salary before starting a PhD and accepted it for different reasons. They said that they were used to it due to their student life before starting their PhD (e.g., lifestyle, rent, shared apartments). Some even mentioned that they started their PhD right after their master's degree because they thought it would be easier to keep the same lifestyle instead of lowering it again after a few years of working in the free economy. PhD students who stopped working in private enterprises to do their PhD mentioned that they had to get used to the decrease in salary but were ok with the situation. Albeit not being as high as in private enterprises, they argued that the wage was high enough to afford a living. Furthermore, one interviewee stated that they valued their passion more than a high salary.

Also, we identified three groups who were quite satisfied with their financial situation: PhD students with a scholarship, a third-party project, or with financial support from their company (e.g., sabbatical with the same salary).

Aside from the financial reward, we also asked the participants how satisfied they were with the material rewards. Most of the interviewees stated that they were quite satisfied. They were sufficiently provided with software and hardware, had access to offices, printers, program licenses, and, in some cases, a budget to compensate research participants. A few participants mentioned room for improvement, e.g., the allocation of work laptops, next-generation laptops, height-adjustable desks, or the access to charged software programs. Representative quotes for both financial and material reward can be found in Table 7 respectively.

Table 7. Sample quotations for financial and material rewards

Financial rewards	Material rewards
"As I said, I have a 75% job at the university. Of course it's not fair in terms of working hours and stress, but I knew before that it was unfair. I had a different motivation for these 3-4 years. You can live with the salary, but you can't save or have a luxury life with it." *"The problem is my salary. It's not that good compared to the free economy, but for me passion is more important than money."* *"But as I said, you don't do a PhD for material reasons, but for ideal reasons. This is a decision that everyone has made for themselves, so one can argue that it is still justified during the PhD. Later I think it's clearly a difficult topic."*	*"I am happy with the environment I have. I will get the software I need for my research or access to computer rooms for experiments and trials. It's okay. Everything else is just my personal equipment, which is okay, but not perfectly designed for a PhD. That means, I just take what I have instead of buying something extra."* *"There are still work laptops to come. I think that is important because it helps you to switch off. … I have an office that is somehow central, that's great and good. I also think that university offices should be equipped with large standing tables because that simply contributes to health, and I think that should be standard now."*

Effort-Reward-Imbalance

When asked about how they would describe their ratio of efforts and rewards during their PhD, more than half of the participants stated that they did not feel properly rewarded for their efforts compared to other PhD students. Most of them felt like the socio-emotional reward and financial reward could be improved. The latter was mostly related to a PhD position at the university with a low salary. Also, interviewees felt like their performance was not adequately rewarded from their personal and professional environment. Further factors creating an imbalance of high efforts and low rewards were the review process and the status-related rewards at the university.

Motivational Patterns for Gaining a PhD Degree

The interviews revealed different motives for why an Effort-Reward Imbalance in the form of high efforts and low rewards would be maintained. The doctoral students mentioned that they were quite aware that a PhD does not lead to instant gratification and that extrinsic motivation decreased during the process. They rather focused on less output-oriented as well as intrinsic and long-term goals, such as the contribution to research by aggregating tangible results, which can be used by other scientists in the future. To reach this goal, some interviewees wanted to become experts in their fields of research. For others the improvement of their own skills and further education was more important than academic success. They enjoyed research and appreciated that they got paid to work on a project that met their personal interests. Furthermore, interviewees valued the flexibility and freedom offered during a PhD, e.g., in form of flexible work schedules. This was especially highly valued by PhD students who had worked in private enterprises before. At the same time, the flexibility also triggered unhealthy work habits, such as working to an unhealthy extent or putting too much pressure on themselves.

Coping Strategies of PhD Students

When designing the study, it was important for us not only to have a look at the efforts, rewards, and motives, but also at coping patterns. As mentioned above, PhD students put in a lot of effort. Especially high workload drained their energy. Therefore, we asked participants how they switched off

and recharged their batteries. We could identify different strategies and classified them into problem-focused and emotion-focused strategies.

Problem-focused coping strategies

Concerning the PhD project there were several problem-focused strategies mentioned. To handle the workload and keep a healthy work-life balance, many PhD students tried to structure their workday and take active breaks. They used different strategies such as working with To-Do Lists, time blocks and breaks (e.g., Pomodoro technique) or orientating their work tasks on their productivity curve. Some even had strategies to make sure that they stopped working by setting an alarm clock or arranging dinner plans. To switch off after work, students also liked to set boundaries, for example, by actively discussing their working hours with their colleagues or setting daily work limits. Some also deleted messenger services and email programs from their personal devices to limit their reachability. In addition, many of the interviewees liked to seek information and assistance from other PhD students. They used formal and informal meetings as well as lunch breaks to discuss problems or exchange views related to their PhD. Often the meetings created new insights on how to deal with specific problems. Additionally, students recognized that others were feeling the same way, which is also an emotion-focused coping strategy. Quotes from the interviews for all three types of problem-focused coping strategies can be found in Table 8.

Table 8. Sample quotations for problem-focused coping strategies

Work routines	Setting limits	Social exchange
"I plan my day with blocks and breaks. … I know that I am most productive in the morning, so I do the more demanding tasks that I think require a higher cognitive performance in the morning and then around noon when I have the feeling that my productivity is decreasing, I tend to do things like answering emails … or organizational stuff." *"I try to divide my days into different categories and work according to them. So for example, I have a couple of hours where I focus on reading papers and others where I focus on writing."*	*"So, for me it is very important that I do not read work emails in the evening and on the weekend because when I read them, I start thinking about work. That means deleting [the e-mail program] from my phone was the most important step for me."* *"With time, I've noticed that you cannot please everyone and that you cannot deliver top quality in all areas, that does not work and look at yourself and ask 'Ok, where do I want to give 100% and where is it enough to do a bit.'. I rather ask myself where I want to give 100% and where it is enough if I do less."*	*"[W]e founded a kind of self-help group with four doctoral candidates in which we regularly meet virtually and talk about how the last few weeks have been, what we have struggled with, what the problems are. I was able to develop an openness that I hadn't experienced in science before. That was really mind-blowing."*

Emotion-focused coping strategies

There were several emotion-focused strategies mentioned in the interviews (see Table 9 for an overview of quotations from the interviews). Almost every interviewee liked to engage in leisure activities to switch off from work, especially physical activities or by spending time with family and friends. PhD students also referred to calm and creative activities, such as reading, meditating, knitting, or playing the piano. Some also liked to switch off from work by consuming media, for instance, by listening to music, playing video games, or watching TV. One of the interviewees even liked to combine watching TV with a self-care routine, e.g., by painting her nails. Further self-care routines were related to sleeping strategies, such as sleeping in. Another emotion-focused coping strategy was to get distance from work during the weekend and taking active breaks or going on vacation. Furthermore,

PhD students liked to cope with stress by actively motivating themselves, especially in tough times (e.g., by asking themselves why they started their PhD). In addition, we could also identify less effective strategies, such as keeping busy with other projects or doing household work. Interestingly, some PhD students seemed to be aware that those coping strategies only offered short-term solutions to their problems. For example, one external PhD student stated that keeping busy with projects from her company is probably not refueling her energy.

Table 9. Sample quotations for emotion-focused coping strategies

Engaging in leisure activities	Distance from work	Less effective strategies
"Hmm, I really like going out, so I go for walks and that helps me to switch off completely and at the same time when I switch off, the best ideas for any problems come up." *"Then definitely sport, it gives me an incredible amount of energy and also lets me switch off. So, I really enjoy swimming, running and doing yoga and, umm, that's when I very rarely think about the doctorate.* *"Meditating, not that long, but that always gets me out quite well. Going for a walk always gets me out as well. Also doing sports or simply distraction, i.e. meeting friends, making music."*	*"When I get out on Friday, I try to stop working and not to work at the weekend … and that works quite well."* *"I then decided for myself, for example 'I have a weekend' and quite rigorously so, 'weekend is weekend. I don't work then'. I don't think about the dissertation then and the dissertation does not exist."* *"It helped me to say 'I have this free time and I will not let it be taken away from me … because that is my time where I have free time where I can pursue my hobbies'. Similarly, I say 'I stop working at 6 p. m', and the evenings belong to my friends, me, and my hobbies and work does not belong there."*	*"I work [on projects of my company], but that's not always refueling energy. So when I work and do things that probably aren't cognitively demanding, then I can switch off quite well."* *"There is a lot of things to do, such as cleaning at home* [laughs] *or I like to do my nails or to watch TV, but the problem with watching TV is that you sometimes cannot stop."*

DISCUSSION

The study provided unique insights into the perceived efforts, rewards, motives, and coping strategies of PhD students in Germany by using a qualitative research approach and renowned stress models. Following the theoretical framework of the Effort-Reward-Imbalance model (Siegrist, 1996) and the Transactional Model of Stress and Coping (Lazarus & Folkman, 1984), we created a comprehensive coding system. To adapt the model to the PhD context we expanded the system by several sub-categories (see Appendix C).

We identified crucial efforts caused by the PhD project and efforts in addition to the project. On a work-related level, most PhD students struggled with the nature of the project (e.g., long-term project, little teamwork), which evoked feelings of isolation and uncertainty, lack of inspiration, problems of motivation, and detachment from work. Some interviewees also mentioned that they struggled with the scientific approach, especially with the feedback process by reviewers and supervisors. Common efforts aside from the PhD project were social obligations as well as work-related efforts in addition to the actual PhD project. Those efforts were also commonly stated in other studies (Mackie & Bates, 2019; Schmidt & Hansson, 2018; Tomasz & Denicolo, 2013).

While looking at the rewards, we focused on status-related, socio-emotional, and financial rewards. For socio-emotional rewards, we could identify rewards on a personal and professional level, such as

appreciation from family, encouragement, and emotional support from family, friends, other PhD students, supervisors, and colleagues, or scholarships. Status-related rewards were divided into the sub-categories job security, career promotion, and professional development opportunities. It became quite clear that a lot of the interviewees saw the university system as burdensome, especially regarding the academic fix-term contract act and the requirement of mobility. Compared to work in the private sector, the university system was less attractive, especially regarding career promotion opportunities as well as the financial rewards offered by the university. The mismatch between workload and wage was often criticized particularly by students working at the university.

Additionally, our study identified five different motives for gaining a PhD degree: (1) an intrinsic motivation, (2) an interest in improving one's skills, (3) becoming an expert, (4) contribution to research, and (5) the flexibility and freedom offered by a PhD degree. Compared to the theoretical framework of the Effort-Reward-Imbalance model, the motive for doing a PhD due to career promotion opportunities was not explicitly stated by the interviewees. Those students who mentioned career promotion opportunities explained that the interest in the title got less important for them during their PhD process while their intrinsic motives became stronger. Some interviewees even expressed explicitly that an intrinsic motivation is necessary for gaining a PhD degree. Interestingly, all interviewees explicitly used the word "intrinsic". This might be because many interviewees were striving for a PhD degree in Psychology. Therefore, we believe that most of our interviewees related to the common definition of intrinsic motivation from Ryan and Deci (2000, p. 56), which defines intrinsic motivation "as the doing of an activity for its inherent satisfactions rather than for some separable consequence. When intrinsically motivated a person is moved to act for the fun or challenge entailed rather than because of external prods, pressures, or rewards." This assumption is backed up by interview statements that expressed that PhD students gained a PhD out of fun, joy, and personal interest. Prior studies showed the consequences of intrinsically motivated PhD students; for example, they were more likely to persist in a doctoral program (Hoskins & Goldberg, 2005).

In addition to the investigation of efforts, rewards, and motives, the study took into consideration how PhD students cope with stress. We could identify three different problem-focused and five different emotion-focused coping strategies. Most commonly, PhD students coped with stress by being physically active, meeting friends, having work routines, or seeking assistance from other PhD students. In line with Schmidt and Hansson (2018), we believe that some coping strategies might have a dual function as stressors and coping opportunities, such as spending time with family and friends. On the one hand, interviewees felt pressured to find time for free time activities. On the other hand, they actively planned and engaged with their personal environment to switch off. The dual function caused by obligations in childcare were not reported in our interviews – probably because of the low number of participants with children. This should be taken into consideration while interpreting the results, especially as other studies already showed that PhD students struggled to juggle between work and family (Wasburn-Moses, 2008). This might cause feelings of guilt, worry, and anxiety (Smith et al., 2006). Therefore, some coping strategies should also be considered as being part of the effort category of the Effort-Reward-Imbalance Model.

Comparison of Findings to Literature

In this section, we discuss the findings of our study by comparing them to the prior literature. Firstly, we focus on the efforts that PhD students reported in our study and relate them to prior studies. During our study, we could see obvious parallels to other studies that reported PhD project related efforts, such as feelings of isolation (Grady et al., 2014; Tomasz & Denicolo, 2013), uncertainty (El-Ghoroury et al., 2012; Lau & Pretorius, 2019), as well as efforts aside from the PhD project, e.g., teaching. Interestingly, many studies focused in great detail on the specific effort categories of the relationship with the supervisor or the feedback process (Ives & Rowley, 2005). Our study, however, intended to get a broad picture about all efforts that could affect work stress of PhD students. This has two major advantages. Firstly, the efforts that have been investigated can be connected to each

other (e.g., work-related and non-work-related efforts) and secondly, they give a variety of implications on how to improve the work situation of PhD students in several different aspects (e.g., behavior of supervisors, postdoc, family). According to Volkert et al. (2017) the main obstacle for leaving academia is having an unsupportive personal environment as well as a difficult supervisor relationship. Both issues have also been clearly raised by our interviewees. PhD students with a non-academic family background often reported about family members who struggled to understand the sense of a PhD and were less supportive. Besides, our students reported about obstacles caused by a burdensome supervisor relationship.

Furthermore, our study shed a different light on the socio-emotional, status-related, and financial rewards. While especially the financial situation of PhD students is often described as miserable (Chen, 2021; Hunter & Devine, 2016), our study implies that the perceived situation differs between different types of PhD. Whereas the financial situation of PhD students working at the university is perceived as unsatisfying, external PhD students often do not have a problem with their financial situation and future prospective as they are supported by a company and will go back to their company after finishing their doctoral degree. Including different types of PhDs and rewards, we gained a broad picture of the perceived rewards that could influence work stress of PhD students instead of looking at single aspects, such as the reward from family members (Breitenbach et al., 2019) or supervisors (Ives & Rowley, 2005).

Our interview also investigated motivational patterns for doing a PhD degree and clearly showed that most of the motives were of intrinsic nature. For example, PhD students wanted to become experts in their field of study, improve their own skills, and honored the flexibility and freedom offered by a PhD degree. This is similar to the results from Morton and Thornley (2001) and Leonard et al. (2005), who showed that students gained a PhD degree out of interest in the subject, one's own development, and improvement of research skills. However, previous studies also showed a variety of other motives, such as career success and social justice (Pretorius & Macaulay, 2021) or the encouragement of family and friends or lectures (Guerin, 2015). This could be explained by the group of PhD students we mainly interviewed. As the study by Tarvid (2014) shows, the motivation can vary between different fields of study by exploring three different groups of PhD students. The author reported that Group 2, which mainly consisted of natural science students, showed a much stronger labor market orientation than Group 1, which included psychology students. Therefore, it should be taken into consideration that our study might not show all motives of PhD students to pursue a doctoral degree. Also, it must be taken into account that motives vary by internal and external factors, e.g., age, interest, personal goals, family support, or fit with supervisor (Sverdlik et al., 2018).

Furthermore, we asked our interviewees how they cope with stress and divided their answers into problem- and emotion-focused coping strategies. In accordance with past findings, our interviewees used common coping strategies, e.g., work routines and engagement in leisure activities, being physically active, or spending time with family and friends (Byers et al., 2014; Martinez et al., 2013; Smith et al., 2006). We also found hints for self-handicapping coping strategies. However, these results were rather superficial, while other studies have explored them in more detail. They describe, for example, busyness, perfectionism, procrastination, regular changes of the thesis topic, or avoiding communication as self-handicapping coping strategies (Ahern & Manathunga, 2004; Kearns et al., 2008).

Strengths and Limitations

There are considerable strengths in this study. Our sample consisted of heterogeneous participants (e.g., in terms of age, gender, fields of study, employment types, and PhD duration). Thereby, we were able to capture different perspectives on efforts and rewards in the academic field as well as different strategies to cope with them. We used a purposeful strategy to analyze the data (Mayring, 2003) and rich descriptions to improve the transparency and trustworthiness of our results (van Nes et al., 2010). Furthermore, we based our results on theoretical frameworks and evidence from prior

studies (Malterud, 2011). However, the unique contribution of the study is that we focused on work stress of PhD students by implementing the effort-reward-imbalance model and combining it with the Transactional Model of Stress and Coping. To the knowledge of the authors, this has not been done before.

Also, some limitations should be considered when interpreting the findings of this study. In our study, we identified that the participants' understanding of "efforts" and "rewards" varied. Several of the interviewees asked if we could further define both categories. Also, most participants initially reported financial rewards. Material rewards were only addressed after follow-up questions were asked. It might be possible that the material rewards (e.g., software and hardware, program licenses) were less important to PhD students or that the word "material" led to confusion, as some of our interviewees requested examples. During the coding process, we were also questioning if the terms of the Effort-Reward-Imbalance model require a general adjustment as some terms led to confusion and did not perfectly match the context. For example, it was quite unclear how to differentiate best between a high intrinsic motivation and overcommitment. We, therefore, recommend setting definitions of the categories based on theoretical models before starting the analyzation process.

Also, the findings are not representative of PhD students in general due to the chosen sampling method and a variety of other factors. By using qualitative research methods and non-probability sampling, the results cannot be generalized. In our sample, most PhD students pursued a degree in Psychology at the two biggest universities in Bavaria, while other research subjects and universities were only represented by one individual. Similarly, the number of participants of different funding types varied. While the number of PhD students working at the university, having a scholarship, or gaining a PhD externally were balanced, only one PhD student at a non-university research organization took part in our study. As we based our interview guide on established theoretical models, we might have missed a bigger variety of perceived efforts and rewards. It is further important to mention that the interviews varied greatly in richness of detail, which is also mirrored in the time range of the interviews. This could be influenced by the satisfaction with the PhD program (e.g., PhD students who were unhappy with the situation mentioned more challenges). Also, it should be considered that we only investigated the perspective of the PhD students while looking at efforts, rewards, motives, and coping strategies. Perspectives of the supervisor, colleagues, family, and friends are missing. This is due to the fact that the Effort-Reward-Imbalance model is focusing on the individual and its perceived stress factors. Therefore, future research should compare perspectives of both PhD students and their social environment.

As the participation in the interviews was voluntary, participation out of interest or discontent with the prevalent university system might have biased the results. Furthermore, it is difficult to compare the data with findings from past decades and other countries due to altered student profiles and changes in the conceptualization of doing a PhD (Acker & Haque, 2014). The temporal context of the study period should also be noted: the interviews were conducted during the COVID-19 pandemic, which might have affected the perception of efforts and rewards (e.g., home office, virtual lectures, social distancing).

Theoretical and Practical Implications

The results of our study provide insights into numerous types of efforts, rewards, motives, and coping strategies of PhD students and allow us to draw several theoretical and practical conclusions. In terms of research-related implications, we ask for more qualitative as well as quantitative methods. This allows us to follow the approach from Hoskins and Goldberg (2005) and Wao and Onwuegbuzie (2011) to explore the PhD population with more qualitative methods and offers, on the other hand, the opportunity to generalize and quantify our results with a higher sample size. Especially in a context in which established models have not been applied before, qualitative approaches offer great possibilities to gain first insights into what degree these models apply in these contexts. Subsequently, the results can be generalized and quantified with a higher sample size using qualitative

measures. We also invite other researchers to look at different PhD settings instead of focusing on PhD students at the university because we noticed that efforts and rewards strongly varied between different PhD settings (e.g., external PhD, graduate school PhD, working at the university, or scholarship holders).

Practical implications can also be derived from our insights on coping strategies in combination with efforts such as "being constantly available". PhD students should be informed at the beginning about the requirements of a PhD to lessen the burdens and to teach them how to handle different stress factors. Doing so, they could get important hints about job crafting skills that are necessary to handle potential mismatches between efforts and rewards and prevent negative health outcomes (Creed et al., 2020).

Accordingly, we recommend including the results of this study into a concept for PhD-themed kick-off events or mentoring programs that accompany and support the PhD students from the beginning and help to overcome obstacles. Also, workshops should be integrated into the PhD journey. Firstly, effective coping strategies can be developed (e.g., recovery and emotion regulation trainings) and, secondly, workshops can specifically act as countermeasures against the reported efforts. The PhD students reported, for example, about work-related efforts, such as problems with time and project management as well as with the scientific approach of the project. These efforts could be tackled by offering workshops on working techniques (e.g., time management, project management) or improvement of scientific skills (e.g., statistical methods, academic writing, and publishing). Furthermore, mindfulness workshops should be taken into consideration (e.g., mediation, stress management, strategies to detach from work) as well as networking workshops that help students to connect and exchange their experiences. Importantly, the exchange with advanced PhD students seemed to be highly valued by our interviewees. Therefore, we suggest a peer-to-peer mentoring program. During our discussions, we also thought about an exchange platform where different disciplines and less and more experienced PhD students can exchange their experiences, tips, or ask for input. This could also influence the socio-emotional rewards and the "networking" effort, which was not directly related to the PhD project but often reported as an effort in addition to the PhD by our interviewees.

Besides, it is highly relevant to inform the organizational level (and especially the supervisors) how they can incorporate the findings into the university system, as they are mostly responsible for offering PhD workshops, improving PhD programs, and helping to create a good "leadership" culture. Supervisors should be informed about the efforts, rewards, motives, and coping strategies of PhD students, e.g., via workshops and newsletters. This information can be helpful for them to further support their students. In addition to introducing coping strategies to their PhD students, the responsible university staff should also be aware of how their own behavior influences the work stress of PhD students. For example, supervisors should acknowledge that the amount of pressure and workload they put on their PhD might influence negative health outcomes. By learning about the Effort-Reward-Imbalance model, they could achieve a better fit between the PhD student and the project by setting clear goals and expectations in accordance with their PhD candidates. Additionally, considering the rewards system, supervisors should learn how to show their appreciation and support on an emotional level (e.g., how to give feedback) and also on a financial level (e.g., financing participation in a conference). This would show their students that they are willing to offer opportunities for career development that might act as a countermeasure against the increasing worldwide trend of doctoral graduates leaving academia.

In future studies, effects of different coping strategies should be explored. So far, it is quite unclear which strategy has the greatest impact on the Effort-Reward-Imbalance in PhD students. The efforts and rewards are likely to be part of a complex interplay of personal and doctoral stress (Brown & Watson, 2010; McAlpine & McKinnon, 2013). The coping strategies could also be influenced by the PhD stage, as previous studies showed that most of the PhD students especially struggled during their first PhD year (Ali & Kohun, 2006). As students with a non-academic background face addi-

tional stressors in their personal environment (Holley & Gardner, 2012), it is recommended to consider different types of PhD students in future research. Therefore, additional work is required to explore how the coping strategies interact or influence different outcomes. Longitudinal studies and interventions are necessary not only to understand the changes in efforts and rewards of PhD students, but to investigate ways improve their situation.

CONCLUSION

The findings of this study show that the Effort-Reward-Imbalance model (Siegrist, 1996) and the Transactional Model of Stress and Coping (Lazarus & Folkman, 1984) is applicable in the context of PhD students. The results pose a sound theoretical framework to explore efforts, rewards, and motives of PhD students as well as problem-focused and emotion-focused strategies to cope with stress during a doctoral training. Furthermore, the use of a qualitative methodology displays that PhD students stated additional efforts, rewards, and motives besides the classical Effort-Reward-Imbalance questionnaire (Siegrist, 2012), such as non-work related efforts and efforts aside from the PhD project. It is important to emphasize that not only PhD students themselves but also the management level and especially the supervisors have a huge impact on the perceived efforts and rewards of PhD students, as well as the PhD students' setting (e.g., external, internal). Therefore, the perceived efforts and rewards can be influenced by countermeasures on a variety of different PhD stages as well as on a personal and organizational level. On a personal level, PhD students can be informed about stress factors and coping strategies by kick-off events and personal development workshops. Their supervisors can be included in the process via mentoring programs, which help to create a better relationship and feedback process. On an organizational level, the knowledge should be incorporated in the recruiting process and supervisor workshops. All these measurements are elementary to promote healthy behaviors in the PhD journey of a student. If these measures are encouraged from the beginning, they could work as a countermeasure against a potential imbalance between efforts and rewards that can lead to mental health issues such as depression.

ADDITIONAL STATEMENTS

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AUTHORS' CONTRIBUTIONS

Melanie Vilser conceptualized the study, conducted, transcribed, coded the interviews, and drafted the first version of the paper. Sabrina Rauh coded the interviews independently of Melanie Vilser. Later versions of the papers were discussed with Sabrina Rauh, Irmgard Mausz, and Dieter Frey. All authors approved the final paper.

INFORMED CONSENT

Informed consent about participation in the study was obtained from all participants.

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

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APPENDIX

APPENDIX A - INTERVIEW GUIDE

Warm-Up

- How did you get into doing a PhD?*[1]

Motives

- Please describe your own work style.*
- What drives you to do a PhD despite the challenges and burdens?
- What demands do you make on yourself regarding your doctorate?

Efforts

- Please explain your typical doctoral activities.*
- What requirements and obligations do you have regarding your PhD?
- What (further) obligations do you have apart from your PhD project?
- What do you perceive as exhausting or burdening during your doctorate?

Effort-Reward-Imbalance

- Compared to other PhD students, how would you describe your ratio of efforts and rewards?

Rewards

- Socio-emotional rewards
  - How would you describe your relationship with your supervisor / colleagues / other PhD students?*
  - Do you think that your efforts are valued appropriately?
  - Who supports you during your doctorate and how?
- Status-related rewards
  - How do you feel about the opportunities for career promotion and professional development?
  - How do you feel about the opportunities for job security?
- Financial and material rewards
  - How satisfied are you with your doctorate in financial and material terms?

Coping strategies

- Are you able to switch off from your doctorate?
- How do you switch off and recharge your energy?

Closing

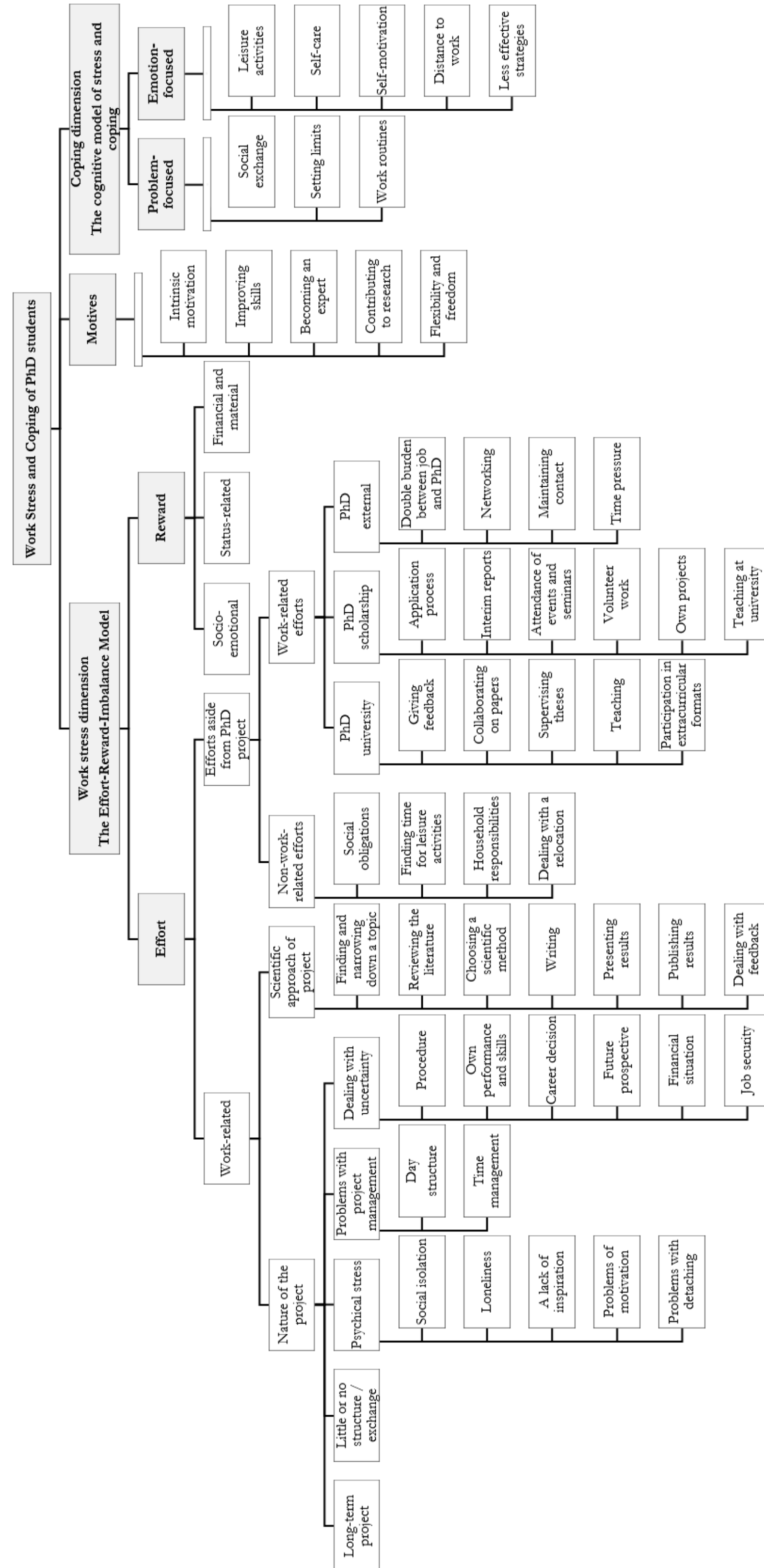
- I have asked all my questions. Can you think of anything else that you would like to add or report regarding your PhD?

[1] Questions with a * functioned as warm-up or transition questions.

APPENDIX B - UNCERTAINTY THEMES

Types of uncertainty	Typical questions from the interviewees
Procedure	How does a PhD work? Which statistical method should I use? Am I going to lose interest in other topics due to the limited free time?
Own performance and skills	Am I really good at the doctorate? Are other scientists better than me? Is my work good enough? Have I done enough for my PhD during the week, or should I have accomplished more? Man, what did I actually do today?
Career decision	Does a scientific career really suit me? Did I make the right career decision? Will the PhD be of any use for me if I do not manage to stay in science? Are my qualifications too high for the job I want to apply for?
Future prospective	Where am I going in the future? What will I do after my PhD? What does my future look like? What comes next, will it be science or not?
Financial situation	How am I going to afford my pension? Can I put enough money aside for my future? Will I get a scholarship? Will I have enough money at the end of the month / next month? How am I going to pay my bills? Should I drop out because I can't afford living? How am I going to fund my PhD when the financial support stops?
Job security	Will my contract be extended? Will I finish my doctorate in the financed time?

APPENDIX C – CONCEPTUAL FRAMEWORK OF THE STUDY



AUTHORS

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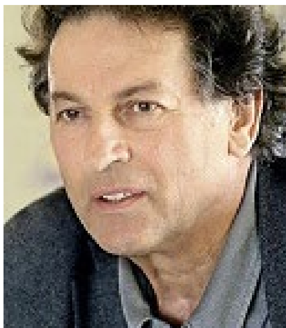

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