

**The Influence of Individual Preferences,  
Institutional Conditions, and their  
Antecedents on Academic Research  
Careers of Life Scientists**

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## To my daughters

You are the love of my life,  
The engine of my being,  
The storm in my structure,  
And with you, every little step is an adventure.

## Abstract

Insecure career paths and precarious working conditions in academic research careers are widely debated issues in the international context as well as in Germany. Previous studies on academic research careers have already indicated that both institutional conditions (e.g., characteristics of a position as life science doctoral candidate at a German university) and individual factors (e.g., academic career aspirations) shape career paths in academia. So far, it is not fully understood how institutional and individual factors are related in explaining career decisions. Therefore, this dissertation was to investigate both institutional and individual factors for exploring mechanisms behind decisions in academic research careers. The often-cited *research career conceptual framework (RCCF)* on investigating career decisions in academic research careers—published after starting data collection—considers both aspects, too (Cañibano et al., 2019). Therefore, this conceptual framework seems to be beneficial for discussing results of this thesis and for embedding them in up-to-date research. However, this framework falls short in considering antecedents of institutional conditions and individual preferences despite existing evidence for antecedents by previous research. On the basis of theoretical and empirical assumptions, the RCCF is extended to the eRCCF in this doctoral thesis. Individual-level antecedents (basic need-supportive environment, scholarly identity, and achievement emotions) as preconditions of individual preferences as well as recommendations of policy (on improving structured doctoral training programs) as structural antecedents affecting institutional conditions are integrated.

In order to examine influencing factors of career decisions, this doctoral thesis was aimed at (1) examining if recommendations of policy and previous research results as structural antecedents had already been implemented in the regulations of structured doctoral training programs as institutional conditions of doctoral education relevant for career decisions in academia. Furthermore, this dissertation was to (2) analyze individual-level antecedents during doctoral studies (gauged as perceived competence support, perceived autonomy support, and social relatedness to the scientific community) associated with later scholarly identity and academic career aspirations as individual preferences related to career decisions in academia. Third, this study was aimed at (3) examining emotional experiences during research and their predictors in the social environment (gauged as perceived competence support, perceived autonomy support, and social relatedness to the scientific community) as individual-level antecedents. Characteristics of academic positions as institutional conditions were also considered.

These three aims were addressed within the *E-Prom*-project on *Influencing factors on academic career paths of graduated life scientists*. The Federal Ministry of Education and Research (BMBF) funded research of this project on graduated life scientists in Germany (life science research includes biology, medicine, chemistry, and other natural sciences investigating questions on life): in the study on doctoral programs, regulations and further documents on institutional conditions in structured doctoral training programs, where participants of the study on researchers' experiences conducted their doctoral studies, were analyzed. In the study on researchers' experiences, two surveys were conducted. In a multi-cohort panel study, graduated life scientists answered to a questionnaire on institutional conditions, individual preferences, and individual-level antecedents during doctoral studies and later career stages once a year since doctoral graduation. Additionally, researchers of all career stages working in academia participated in a cross-sectional survey on their working conditions (institutional conditions) and experiences (individual preferences and individual-level antecedents) in academia. Aim one was addressed within the study on doctoral programs investigating regulations of  $N = 82$  structured doctoral training programs in the life sciences as a document analysis. Aim two was addressed within a subdataset of the multi-cohort panel study including  $N = 180$  participants answering relevant scales in the online-questionnaires at two dates of the survey (study on researchers' experiences). Aim three was addressed within the cross-sectional study on  $N = 250$  doctoral graduates in different academic career stages in the life sciences (study on researchers' experiences).

Analyses of this doctoral thesis led to results on conditions in academia before and after doctoral studies: (1) doctoral education in German structured doctoral training programs still did not implement recommendations of policy and research results as structural antecedents to a sufficient extent in their regulations—particularly regarding interdisciplinary aspects, international orientation, training offers, supervision, and examination of doctoral studies. (2) Researchers' experiences during doctoral studies—especially, perceiving social relatedness to the scientific community—were crucial individual-level antecedents related to later aspirations to pursue an academic career path as individual preference. This relationship was mediated by the scholarly identity of the researchers. (3) Furthermore, researchers' experiences in the academic environment (perceived competence support, perceived autonomy support, and social relatedness to the scientific community) were relevant predictors in emotional experiences of researchers after doctoral graduation. Additionally, an academic position with leading responsibility was associated with a more positive emotional pattern than academic positions without leading responsibility.

Results of this doctoral thesis hint that there are still various aspects in academia related to precarious working conditions and insecurity of career paths which may hamper academic research career progress. (1) First, structured doctoral training programs should implement further recommendations of policy and research (structural antecedents) in their regulations (institutional conditions) in order to further improve doctoral education. (2) Second, through fostering doctoral candidates' social relatedness to the scientific community as a crucial individual-level antecedent, academia can increase the probability that the doctoral graduates aspire to stay on the academic career track. (3) Third, considering their academic staff's basic psychological needs as well as fostering the possibility to get academic positions with leading responsibility after doctoral graduation can enhance positive emotional patterns. Consequently, both individual preferences and their antecedents should be further considered in research on academic research careers besides institutional conditions and structural antecedents for capturing complexity of career decisions in academia.

On the basis of the results of this doctoral thesis, the extended framework eRCCF for investigating academic research careers had been concretized by incorporating empirical findings of this thesis for explaining the relationships of the individual-level antecedents, the individual preferences, the structural antecedents, and the institutional conditions. The enhanced eRCCF including empirical findings suggest that the composition of factors influencing career decisions is more complex than previously assumed when institutional conditions, individual preferences, and their antecedents influence each other mutually. The enhanced eRCCF can be used in further research for predicting and analyzing career decisions in academia in more detail to further converge with complex reality.

## Zusammenfassung

Unsichere Karrierewege und prekäre Arbeitsbedingungen im Verlauf von Wissenschaftskarrieren werden sowohl international als auch in Deutschland vielfach diskutiert. Vorherige Forschung zu Wissenschaftskarrieren hat bereits gezeigt, dass sowohl institutionelle Bedingungen (z.B. Bedingungen einer Stelle als Doktorand<sup>1</sup> in den Lebenswissenschaften an einer deutschen Universität) als auch individuelle Faktoren (z.B. wissenschaftliche Karriereaspirationen) Karrierewege in der Wissenschaft beeinflussen. Bisher wurde noch nicht vollständig aufgeklärt, wie die institutionellen und individuellen Faktoren zusammenhängen und wie dieser Verbund von Faktoren Karriereentscheidungen in der Wissenschaft beeinflusst. Daher sollen in der vorliegenden Dissertation sowohl die institutionellen als auch die individuellen Faktoren untersucht werden, um die Mechanismen zu erkunden, die Laufbahnentscheidungen während wissenschaftlicher Karrieren zugrunde liegen. Das viel zitierte konzeptuelle Rahmenmodell zur Untersuchung von Entscheidungen in Forschungskarrieren (*research career conceptual framework, RCCF*) – publiziert nach der Datenerhebung – berücksichtigt ebenfalls diese beiden Aspekte (Cañibano et al., 2019). Daher scheint dieses Rahmenmodell vielversprechend zu sein, um die Ergebnisse der vorliegenden Arbeit zu diskutieren und in aktuelle Forschung einzubetten. Jedoch berücksichtigt dieses Rahmenmodell nicht, welche Faktoren den institutionellen Bedingungen und individuellen Präferenzen vorhergehen, obwohl bisherige Forschung bereits Belege für solche vorhergehenden Faktoren geliefert hat. Basierend auf theoretischen Annahmen und empirischen Belegen wurde das bestehende RCCF in dieser Dissertation um individuelle Faktoren zum eRCCF ergänzt (z.B. ein die psychologischen Grundbedürfnisse unterstützendes Umfeld, Wissenschaftleridentität und Leistungsemotionen), die den individuellen Präferenzen vorhergehen. Zudem wurden Empfehlungen zur Verbesserung aus Politik und Forschung (z.B. zur Verbesserung strukturierter Promotionsprogramme) als strukturelle Faktoren im eRCCF ergänzt, die den institutionellen Bedingungen vorhergehen.

Um Einflussfaktoren von wissenschaftlichen Karriereentscheidungen zu untersuchen, soll in dieser Arbeit (1) überprüft werden, ob Empfehlungen zur Verbesserung strukturierter Promotionsprogramme aus Politik und Forschung (vorhergehende strukturelle Faktoren) bereits in den Bestimmungen der strukturierten Promotionsprogramme (institutionelle Bedingungen) implementiert wurden. Darüber hinaus sollen in dieser Arbeit (2) individuelle Faktoren während der Promotion analysiert werden, die Karriereentscheidungen in der

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<sup>1</sup> In der gesamten deutschen Zusammenfassung bezieht sich das generische Maskulinum sowohl auf alle weiblichen, männlichen als auch diversen Forschenden.

Wissenschaft vorausgehen. Dabei werden sowohl individuelle Faktoren als wahrgenommene Kompetenz- sowie Autonomieunterstützung und die soziale Eingebundenheit in die wissenschaftliche Gemeinschaft assoziiert mit der Wissenschaftleridentität untersucht als auch wissenschaftliche Karriereaspirationen als nachfolgende individuelle Präferenzen. Drittens sollen (3) emotionale Erfahrungen während des Forschens und das Erleben des sozialen Umfelds (erhoben als wahrgenommene Kompetenzunterstützung, wahrgenommene Autonomieunterstützung und soziale Eingebundenheit in die wissenschaftliche Gemeinschaft) als vorhergehende individuelle Faktoren untersucht werden. Außerdem werden hier die Bedingungen der Positionen im Wissenschaftsbetrieb als institutionelle Bedingungen berücksichtigt.

Im Rahmen des *E-Prom-Projekts zu Einflussfaktoren auf die Karriere Promovierter in den Lebenswissenschaften* wurden die drei Ziele empirisch untersucht. Das Bundesministerium für Bildung und Forschung (BMBF) hat dieses Projekt zu promovierten Lebenswissenschaftlern in Deutschland (lebenswissenschaftliche Forschung umfasst z.B. Fächer wie Biologie, Medizin, Chemie und andere Naturwissenschaften, die Fragen rund um das Leben untersuchen) gefördert: In der Studie zu strukturierten Promotionsprogrammen wurden Bestimmungen und weitere Dokumente zu strukturierten Promotionsprogrammen analysiert, an denen die Teilnehmer der Studie zu den Erfahrungen der Wissenschaftler teilgenommen hatten. In der Studie zu den Erfahrungen der Wissenschaftler wurden zwei Befragungen durchgeführt. In einer Multi-Kohorten-Panelstudie haben promovierte Lebenswissenschaftler einen Fragebogen zu den institutionellen Bedingungen, ihren individuellen Präferenzen sowie vorhergehenden individuellen Faktoren während ihrer Promotion und in späteren Karrierephasen beantwortet. Zusätzlich wurden in einer Querschnittsbefragung promovierte Lebenswissenschaftler aller Karrierestufen, die zum Befragungszeitpunkt in der Wissenschaft arbeiteten, zu ihren Arbeitsbedingungen (den institutionellen Bedingungen) und Erfahrungen (den individuellen Präferenzen und vorhergehenden individuellen Faktoren) in der Wissenschaft befragt. Auf Grundlage einer Dokumentenanalyse von  $N = 82$  strukturierten Promotionsprogrammen in den Lebenswissenschaften aus der Studie zu strukturierten Promotionsprogrammen wurde das erste Ziel dieser Arbeit untersucht. Das zweite Ziel dieser Arbeit wurde anhand eines ausgewählten Teildatensatzes der Panelstudie mit den Antworten von  $N = 180$  Teilnehmern untersucht, die alle relevanten Skalen in der ersten und zweiten Befragung beantwortet hatten (Studie zu den Erfahrungen der Wissenschaftler). Anhand der Antworten von  $N = 250$  Promovierten verschiedener Karrierestufen in den Lebenswissen-



schaften aus der Querschnittsstudie wurde das dritte Ziel dieser Arbeit untersucht (Studie zu den Erfahrungen der Wissenschaftler).

Analysen im Rahmen der vorliegenden Doktorarbeit haben Erkenntnisse zu Bedingungen in der Wissenschaft sowohl vor als auch nach der Promotion ergeben: (1) Bisher wurden Empfehlungen aus der Politik zur Verbesserung der Promotionsprogramme als vorhergehende strukturelle Faktoren noch immer nicht vollumfassend in den Bestimmungen der strukturierten Promotionsprogramme in der deutschen Doktorandenausbildung umgesetzt – insbesondere noch nicht in den Bereichen Interdisziplinarität, internationale Orientierung, Kursangebote, Betreuung und Bewertung von Promotionen. (2) Erfahrungen der Wissenschaftler während der Promotion – vorrangig die wahrgenommene Eingebundenheit in die wissenschaftliche Gemeinschaft – waren wichtige Einflussfaktoren für den späteren Wunsch, in der Wissenschaft zu verbleiben. Diese Beziehung wurde durch die Wissenschaftleridentität mediiert. (3) Darüber hinaus waren die Erfahrungen der Wissenschaftler im wissenschaftlichen Umfeld (bezüglich wahrgenommener Kompetenzunterstützung, wahrgenommener Autonomieunterstützung und sozialer Eingebundenheit in die wissenschaftliche Gemeinschaft) relevante Prädiktoren emotionaler Erfahrungen von Wissenschaftlern nach der abgeschlossenen Promotion. Zusätzlich war eine akademische Position mit Führungsverantwortung mit einem positiveren emotionalen Erleben von Forschung verbunden als Positionen ohne Führungsverantwortung.

Die Ergebnisse dieser Dissertation weisen darauf hin, dass es weiterhin Aspekte bezogen auf die Arbeitsbedingungen und unsicheren Karrierewege im Wissenschaftssystem gibt, die Wissenschaftskarrieren erschweren können. (1) Strukturierte Promotionsprogramme sollten in ihren Regularien (institutionelle Bedingungen) weitere Empfehlungen aus Politik und Forschung (vorhergehende strukturelle Faktoren) integrieren, um die Doktorandenausbildung weiter zu verbessern. (2) Zudem kann die Wissenschaft die Wahrscheinlichkeit erhöhen, dass promovierte Forscher weiterhin eine wissenschaftliche Karriere verfolgen wollen, indem die soziale Eingebundenheit in die wissenschaftliche Gemeinschaft als vorhergehender individueller Faktor gefördert wird. (3) Um den Wissenschaftlern ein positives Erleben der Forschung zu ermöglichen, kann die Wissenschaft wiederum die psychologischen Grundbedürfnisse sowie die Möglichkeit fördern, Positionen mit Führungsverantwortung zu erreichen. Daher sollten bei weiterer Forschung zu Wissenschaftskarrieren sowohl die individuellen Präferenzen und ihre vorhergehenden Faktoren als auch institutionelle Bedingungen und deren vorhergehenden strukturellen Faktoren weiter berücksichtigt werden, um die Komplexität von Karriereentscheidungen in der Wissenschaft zu erfassen.

Basierend auf den Ergebnissen dieser Dissertation wurde das erweiterte Rahmenmodell eRCCF zur Untersuchung von Wissenschaftskarrieren konkretisiert, indem die empirischen Ergebnisse dieser Arbeit eingearbeitet wurden. So konnten die Zusammenhänge zwischen vorhergehenden individuellen Faktoren, individuellen Präferenzen, vorhergehenden strukturellen Faktoren und institutionellen Bedingungen verdeutlicht werden. Das mit den empirischen Ergebnissen erweiterte eRCCF deutet darauf hin, dass das Zusammenspiel von Einflussfaktoren auf Karriereentscheidungen komplexer ist als ursprünglich angenommen, wenn sich die institutionellen Bedingungen, individuellen Präferenzen und ihre vorhergehenden Faktoren gegenseitig beeinflussen. Das ergänzte eRCCF kann in der zukünftigen Forschung genutzt werden, um Karriereentscheidungen in der Wissenschaft detaillierter vorherzusagen und zu analysieren, um sich so der komplexen Realität anzunähern.

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## List of Publications

- Meuleners, J. S., Boone, W. J., Fischer, M. R., Neuhaus, B. J., & Eberle, J. (2023). Evaluation of structured doctoral training programs in German life sciences: how much do such programs address hurdles faced by doctoral candidates? *Frontiers in Education*, 8(930283). <https://doi.org/10.3389/feduc.2023.930283>
- Meuleners, J. S., Neuhaus, B. J., & Eberle, J. (2023). The role of scholarly identity and basic needs support during doctoral studies on career aspirations of early career scientists. *Studies in Higher Education*. <https://doi.org/10.1080/03075079.2023.2217726>
- Meuleners, J. S., Neuhaus, B. J., & Eberle, J. (2022). Basic needs support and achievement emotions in daily research of life scientists considering academic positions. *Frontiers in Education*, 7(868752). <https://doi.org/10.3389/feduc.2022.868752>

## Declaration of contribution as a co-author

Hiermit wird bestätigt, dass die folgenden drei Publikationen federführend von Frau Julia S. Meuleners im Rahmen ihrer Dissertation abgefasst wurden. Dies geschah zu folgenden Anteilen:

### Publication I

Meuleners, J. S., Boone, W. J., Fischer, M. R., Neuhaus, B. J., & Eberle, J. (2023). Evaluation of structured doctoral training programs in German life sciences: how much do such programs address hurdles faced by doctoral candidates? *Frontiers in Education*, 8(930283). <https://doi.org/10.3389/feduc.2023.930283>

Frau Julia S. Meuleners hat die genutzten Kodiermanuale weiterentwickelt, den Fragebogen für die Expertenbefragung entwickelt, die Daten der Expertenbefragung erhoben, die Daten der Dokumentenanalyse und Expertenbefragung für die Publikation aufgearbeitet, die Daten statistisch ausgewertet, den Artikel konzipiert und ihn federführend geschrieben.

Die Koautorinnen und Koautoren entwickelten das Studiendesign, trugen zur Entwicklung der ursprünglichen Kodiermanuale bei, unterstützten bei der Datenerhebung und -deutung und trugen substantiell zur Überarbeitung der Publikation bei.

### Publication II

Meuleners, J. S., Neuhaus, B. J., & Eberle, J. (2023). The role of scholarly identity and basic needs support during doctoral studies on career aspirations of early career scientists. *Studies in Higher Education*. <https://doi.org/10.1080/03075079.2023.2217726>

Frau Julia S. Meuleners hat die Daten der Panelstudie für die Publikation aufgearbeitet, die Daten statistisch ausgewertet, den Artikel konzipiert und ihn federführend geschrieben.

Die Koautorinnen entwickelten das Studiendesign, stellten die Fragebögen zusammen, entwickelten Instrumente, unterstützten bei der Datenerhebung und -deutung und trugen substantiell zur Überarbeitung der Publikation bei.

### Publication III

Meuleners, J. S., Neuhaus, B. J., & Eberle, J. (2022). Basic needs support and achievement emotions in daily research of life scientists considering academic positions. *Frontiers in Education*, 7(868752). <https://doi.org/10.3389/feduc.2022.868752>

## Declaration of contribution as a co-author

Frau Julia S. Meuleners hat einen Teil der Fragebögen weiterentwickelt sowie einen Teil der Fragebögen selbst entwickelt, die Daten für die Publikation aufgearbeitet, die Daten statistisch ausgewertet, den Artikel konzipiert und ihn federführend geschrieben.

Die Koautorinnen entwickelten das Studiendesign, entwickelten einen Teil der Fragebögen, unterstützten bei der Datenerhebung und -deutung und trugen substantiell zur Überarbeitung der Publikation bei.

München, den 07.08.2023

.....Julia S. Meuleners.....

München, den 07.08.2023

.....Prof. Dr. Birgit J. Neuhaus....

## 1. Introduction

„Working as a scientist is not the safest one, but it is the best work of the world!”<sup>2</sup> A participant of a cross-sectional study on postdoctoral life scientists working in academia within the *E-Prom*-project reported this phrase commenting the survey. The quote emphasizes the dilemma of scientists who passionately conduct research although challenges of academic work are widely debated issues—being a scientist is not a safe career path for several reasons. Generally, too many junior researchers are trained for only a few permanent leading positions in academia, such as permanent professorship positions (Jaksztat et al., 2010). Accordingly, transition to a professorship appointment is highly selective and only a few excellently qualified junior researchers succeed in reaching a permanent academic position. In German academic systems, such final decisions for an academic career are taken very late in scholars’ lives, currently around the age of 40 years or later (BMBF, 2017; Krempkow, 2017). Though uncertainty of reaching a permanent position in academia shapes researchers’ careers for a long period of time. Furthermore, doing research in academia is often linked to less favorable working conditions than employments outside academia (Krempkow, 2017). In academia, many scientists are part-time and/or fixed-term employed, earn low salaries, and work mostly over time (Ates & Brechelmacher, 2013; BuWiN, 2021; Krempkow et al., 2014; Kwiek & Antonowicz, 2015; Teichler et al., 2013) although German higher education policy recommends creating attractive working conditions for winning and keeping the best for science (GSHC, 2023). In Germany, however, modifications in academia are currently being debated and implemented: a video explaining a German law on fixed-term employments in academia (see section 1.1.2) and their necessity for scientific progress and innovation provoked a discussion of general public and researchers about precarious working conditions and insecure career paths in the German academic system on Twitter under the hashtag #IchBinHanna (#IAmHanna). Considering the public indignation, German government takes some mentioned difficulties in their coalition agreement into account (Bradler & Roller, 2022), higher education policy publishes suggestions on fixed-term contracts (GSHC, 2023), and the law on fixed-term employments is currently reformed (BMBF draft bill, 2023) (see section 1.2). Nevertheless, academia competes with non-academic labor market for the best junior researchers—both academic and non-academic employers try to select the best researchers (Krempkow, 2017). Competition between academia and non-academic employers can be illustrated, for example, by the fact that many doctoral graduates work outside academia (Flöther, 2017). Especially in the life sciences, working

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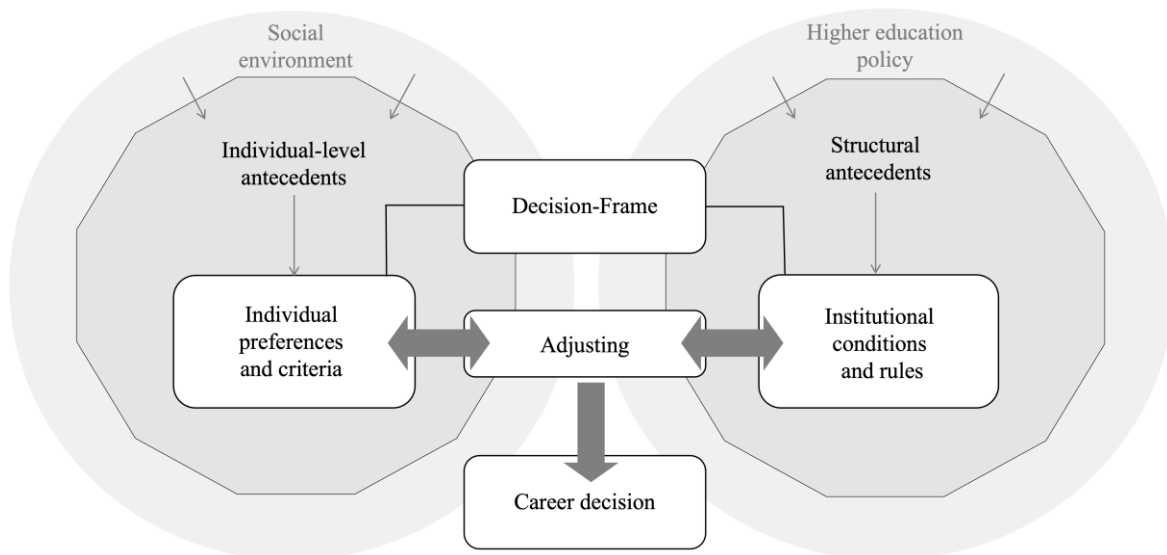
<sup>2</sup> I translated the original German quote into English.



conditions outside academia are highly attractive (Finkelstein et al., 2013; Holden, 2001). However, both academic and non-academic labor market are highly competitive (Klöß, 2010; Mantai & Marrone, 2023; Plasa, 2014). Since most junior researchers aspire academic career paths despite potentially precarious working conditions and insecure career paths in academia as well as good job perspectives outside academia (Jaksztat et al., 2010; Schneijderberg & Götze, 2020), the question arises which factors keep them in academia. There are some research approaches for investigating career decisions in academia considering different clusters of influencing factors each (e.g., Bozeman et al., 2001; Bozeman & Rogers, 2002; Gläser, 2001; Gläser & Laudel, 2007; Laudel & Gläser, 2008; Woolley et al., 2009). There is evidence that both distal institutional factors and proximal individual factors are relevant for drop-out decisions in academia (e.g., Fisher & Ashkanasy, 2000; Litalien & Guay, 2015; Lally & Kerr, 2005; Ortlieb & Weiss, 2018; Reason, 2009; Wollast et al., 2018). Therefore, the question arises how both individual and institutional factors explain decisions for or against further academic research careers in the life sciences. This doctoral thesis was aimed at investigating selected individual and institutional factors influencing career aspirations and decisions at different career stages of academic research careers in the life sciences in Germany.

Research results on academic career paths had already hinted that an interplay of individual and institutional factors is relevant in explaining career decisions (Abele, 2002; Berweger, 2008; Flöther, 2017; Gläser, 2001; Gläser & Laudel, 2007; Laudel & Gläser, 2008) although most studies mainly focused either on institutional or individual factors influencing career decisions (Cañibano et al., 2019). During data collection and analysis of the present doctoral study, the *research career conceptual framework (RCCF)* on investigating academic research careers had been published also considering both individual and institutional factors as in the approach of this thesis (Woolley et al., 2016; Cañibano et al., 2019). Therefore, the RCCF seems to be beneficial for framing this doctoral thesis, for further interpretation and discussion of the results of this thesis in a broader context beyond field- and nation-related particularities, and to embed the results in up-to-date research on explaining career decisions in academia. Cañibano and colleagues established a conceptual framework on researchers' career decisions. In a decision-frame, they assume that researchers adjust their preference to stay on an academic career path and the given institutional conditions. The process of adjusting results in a career decision for or against a further academic research career path (Cañibano et al., 2019). This framework merges some of the individual and institutional factors examined in this dissertation to concisely explain career decision-making in academia. However, individual preferences and institutional conditions do not come out of the blue (Epstein & Elhalaby, 2023;

Ortlieb & Weiss, 2018). So far, the RCCF does not consider antecedents of individual preferences and institutional conditions (Cañibano et al., 2019). Though an extended version of the RCCF on the basis of assumptions of theory and previous research was developed (*eRCCF*): first, the *eRCCF* includes individual-level antecedents (such as the supportiveness of the social environment in academia, identity facets, and affective experiences) associated with individual preferences (such as career aspirations, drop-out intentions, and turnover intentions) (Basarkod et al., 2023; Deci & Ryan, 2012b; Lally & Kerr, 2005; Olafsen et al., 2018; Ortlieb & Weiss, 2018; Pekrun et al., 2023; Robinson et al., 2020; Vallerand et al., 1997; Weiss & Cropanzano, 1996). Second, the *eRCCF* includes structural antecedents (such as recommendations of policy for improving and changing institutional conditions in academia) because, ideally, recommendations of policy cause changes in institutional conditions (BuWiN, 2017) as the development in Germany on the basis of the #IchBinHanna-discussion hinted (e.g., Bradler & Roller, 2022). Particularly, demands of higher education policy served as basis for advancement of the academic system in Germany (for example, the *German Science and Humanities Council (GSHC)* suggested the introduction of structured doctoral training programs in 2002 and about two decades later, many doctoral candidates are enrolled in such programs (GSHC, 2002, 2023)).



**Figure 1. The eRCCF—an extended framework on academic research careers (based on Cañibano et al., 2019; Deci & Ryan, 2012b; GSHC, 2002, 2023; Lally & Kerr, 2005; Olafsen et al., 2018; Ortlieb & Weiss, 2018; Pekrun et al., 2023; Robinson et al., 2020; Vallerand et al., 1997; Weiss & Cropanzano, 1996).** On the left side of the decision-frame, individual preferences and criteria are caused by individual-level antecedents embedded within a social environment. On the right side of the decision frame, institutional conditions and rules are embedded within structural antecedents framed by higher education policy. Finally, a career decision results when researchers adjust their individual preferences and institutional conditions associated with previous individual-level and structural antecedents.

Figure 1 provides an overview of the eRCCF as theoretical extension of the RCCF (Cañibano et al., 2019). In the original RCCF, Cañibano and colleagues (2019) describe individual preferences and criteria as plans and preferences (including intentions among others), knowledge and learning (including research experiences among others), personality and self-awareness (including self-efficacy among others), and society and culture (including gender among others) (Cañibano et al., 2019). However, on the basis of theoretical assumptions and empirical evidence, these individual preferences and criteria have relevant individual-level antecedents (see section 1.3): theoretical assumptions and empirical evidence of the Self-Determination Theory, professional identity, and the Control-Value Theory state that the social environment can be supportive in satisfying basic psychological needs relevant for several psychological factors (for example, identity and emotions) (Deci & Ryan, 2012b; Luyckx et al., 2009; Olafsen et al., 2018; Pekrun, 2006) as individual-level antecedents. Such antecedents at the individual level are related to career aspirations and drop-out intentions (Litalien & Guay, 2015) as aspect of individual preferences within the RCCF (Cañibano et al., 2019). Therefore, individual-level antecedents associated with individual preferences—embedded in the social environment—supplement the eRCCF (see left side in figure 1). In the RCCF, it is assumed that researchers adjust their individual preferences with given institutional conditions.

Institutional conditions exist at different levels—the national or organizational level includes the country specific conditions while the scientific or professional level includes conditions specific for the scientific discipline and training (Cañibano et al., 2019). Since such institutional conditions are mostly debated nationally and internationally (e.g., BuWiN, 2021; Kwiek & Antonowicz, 2015), it seems appropriate to add recommendations of policy as structural antecedents of institutional conditions (e.g., GSHC, 2023; Nerad, 2008) (see right side in figure 1).

This dissertation was to investigate chosen individual-level and structural antecedents as well as individual preferences and institutional conditions in German samples of doctoral graduates in the life sciences. The life sciences unite several research disciplines investigating how to understand life including medicine, biology, chemistry, and other related natural sciences. In order to answer the leading research question, the sections are structured as follows: first of all, a brief overview of academic research careers in the life sciences is given (see section 1.1) including descriptions of the four stages of a typical academic research career: doctoral studies (see section 1.1.1), postdoctoral research (see section 1.1.2), independent research (see section 1.1.3), and professorial research (see section 1.1.3) (Cañibano et al., 2019; EC, 2011; ESF, 2012). Independently from career stages, precarious working conditions and insecure career paths in academia are widely debated issues—nationally and internationally (BuWiN, 2021; Teichler et al., 2013). Therefore, the main key issues in academia are elaborated (see section 1.2). Afterwards, an overview of previous research on academic research careers (see section 1.2.1) and some central recommendations of policy for improving working conditions and career paths in academia are provided for specifying structural antecedents within the eRCCF (see section 1.2.2). In addition, individual factors are included in this study. Three chosen theories relevant for investigating individual-level antecedents associated with individual preferences within the eRCCF are summed up (see section 1.3). The Self-Determination Theory (section 1.3.1) facilitates the examination of experiences in a social environment in academia as relevant prerequisite for several further individual-level antecedents (such as identity facets, emotional experiences) and individual preferences (such as academic career aspirations) (Deci & Ryan, 2012b; Litalien & Guay, 2015; Luyckx et al., 2009). Outlining previous research on professional identity and focusing scholarly identity as the relevant professional identity facet for academic research contexts (Pyhältö, Nummenmaa et al., 2012) allow for analyzing researchers' identity as a further individual-level antecedent. Lastly, a brief overview of the Control-Value Theory for framing researchers' emotional

experiences as achievement emotions in academic competition is provided (Kwiek & Antonowicz, 2015; Pekrun, 2006, 2019).

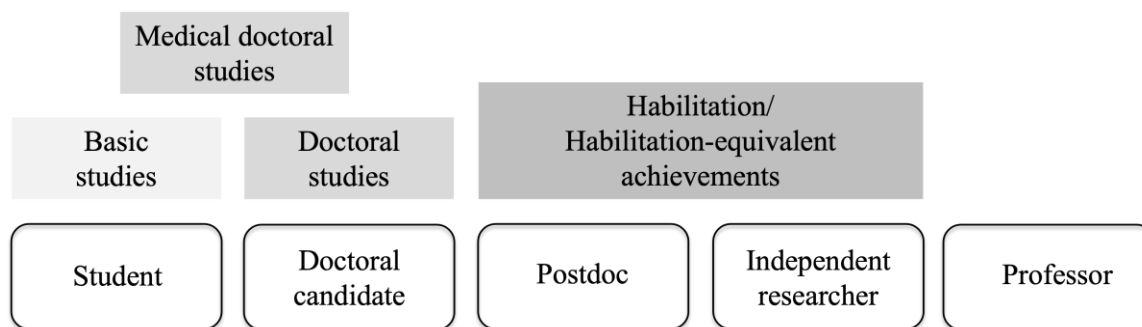
After outlining the investigated individual and institutional factors influencing academic research career decisions, three aims of this thesis are derived (see section 2.). Findings related to these aims are presented in three publications (see section 3.). The results of this doctoral study are summarized and discussed in the following sections separated for each aim and they are embedded within the eRCCF (see section 4.1-4.2). On the basis of the discussion of the results and the outlined limitations of this dissertation (see section 4.3), some further research needs are derived (see section 4.4). Finally, both theoretical implications including a specified eRCCF compiled with empirical hints on relationships of the investigated variables (see section 4.5.1) and practical implications on the basis of the findings of this study are elaborated (see section 4.5.2).

## 1.1 Academic research career paths in German life sciences

Within the eRCCF, the right side includes structural antecedents and institutional conditions (see figure 1). Therefore, in this section the national (German) and scientific (life sciences) level of institutional conditions (Cañibano et al., 2019) are explained and possible academic research career paths are illustrated since the studies of this dissertation are situated in the context of German life sciences.

Research careers may take different forms (academic research careers, research careers in industry or mixed forms) (Cañibano et al., 2019) and can run various paths depending on a variety of factors. For example, institutional factors could be characteristics of available employment positions in and outside academia (for example, the location of such offered positions and necessity of moving) (e.g., Ortlieb & Weiss, 2018). In the life sciences, mostly attractive working conditions in non-academic employments (such as higher salaries, good chances for professional advancement, more permanent positions) (Finkelstein et al., 2013; Holden, 2001) can strengthen competition between academia and the non-academic labor market. However, in contrast to most other life science researchers, biologists' employment prospects after graduation and even after doctoral graduation are worse (BuWiN, 2021; Klöck, 2010; Plasa, 2014). Therefore, academic career paths are highly competitive in biology.

Previous research agreed that most researchers pass four stages of academic research careers on average (Cañibano et al., 2019; EC, 2011; ESF, 2012), explained in the following sections: after doctoral studies as the initial phase for gaining first scientific experiences (see section 1.1.1), researchers continue their academic career by conducting postdoctoral research (see section 1.1.2). Within the third career stage, researchers gain more self-responsibility in independent research (see section 1.1.3). Finally, fully independent scientific research can be conducted during professorial research mostly in permanent professorship positions (see section 1.1.4). Figure 2 provides an overview of these four career stages after basic studies. Since life sciences include also medicine, a special constellation should be mentioned here—most prospective physicians start their doctoral studies already during their basic studies (GSHC, 2011a).



**Figure 2. Overview of possible life science career paths in academia and related qualifications (based on Cañibano et al., 2019; EC, 2011; ESF, 2012; GSHC, 2011a, 2014).** Basic studies (typically completed with a masters degree) are followed by doctoral studies (medical students mostly start their doctoral studies simultaneously to their basic studies). During a postdoctoral phase researchers gain more scientific experiences and may start conducting research for their habilitation or habilitation-equivalent achievements. As independent researchers, they do mostly independent scientific research (employed as junior research group leader, junior professor or in a tenure-track professorship position). Finally, some researchers get appointed as a professor in a permanent position.

### 1.1.1 Doctoral studies

Typically, after graduation in basic studies with a masters degree, many life science researchers complete their doctoral studies (GSHC, 2023) either at a university or a non-university research institute. In Germany, medical students receive their “Approbation”<sup>3</sup> as final graduation when they complete their basic studies including practical education in hospitals during the final year in addition to university studies. For the “Approbation” they do their state examination (ÄAPPO, 2016). Simultaneously, many medical students have already started to conduct their doctoral studies. This approach is a widely debated issue because it may result in medical doctoral studies lacking scientific quality in comparison to other research fields (GSHC, 2011a). Therefore, the *European Research Council (ERC)* as research funder does not accept the German doctoral degree in medicine as qualification for an academic research career (GSHC, 2023). As a consequence, medical faculties introduced structured doctoral training programs with a period of minimally nine months for only doing research (Landkarte Hochschulmedizin Website) (see below for more details on structured doctoral training programs). Generally, doctoral graduation is a basic requirement for the possibility to conduct further independent scientific research in academia. Both researchers’ experiences of support and relationships with supervisors, colleagues, and other scientists as well as achievements during doctoral studies (like the final grade of doctoral studies, the number of published journal articles) are relevant for further career progress in academia (Berweger, 2008; Briedis et al., 2014; Jaksztat et al.,

<sup>3</sup> In Germany, medical students get their official license for practicing as physician with an approbation.

2017). Therefore, it is useful to first explore characteristics, basic aims and typical formats in doctoral education as basis for further analysis on the relevance of doctoral studies in shaping academic research careers.

Unlike international comparison, doctoral education in Germany focuses mainly on first independent research while competing course credits as doctoral student (like in the United States or in England) tend not to be common yet. Though the German approach of doctoral studies is not fully in alignment with the ‘Bologna-Declaration’ of 1999 recommending increased structuring of studies (for example, in fixed curricula including course credits) (GSHC, 2011a, 2023; The European Higher Education Area, 1999). Furthermore, doctoral candidates have to publish their doctoral thesis and take an oral examination or defend their thesis. Examiners state an overall rating of both performances (GSHC, 2011a). Candidates can write their doctoral thesis as monograph or as paper-based thesis (including a defined set of published or accepted papers). Especially in the life sciences, the second option is very common (GSHC, 2011a, 2023).

There are some central requirements of doctoral theses: doctoral studies should be original, doctoral candidates should conduct their studies independently, and the studies should be significant to the respective research field (GSHC, 2011a; Lovitts, 2007). To be able to meet these requirements, doctoral candidates should learn and improve specific academic skills during doctoral studies. Scientists take on six different roles: researchers have to network, collaborate, manage research, conduct research itself, publish research, and, at least, teach research results (Boyer, 1990; Kyvik, 2013). For example, doctoral candidates should learn how to fund research projects (managing research), how to present research results to scientific communities as well as to society (publish research), and how to teach and mentor students with regard to scientific fields (teaching research) (Boyer, 1990; Walker, 2008). Besides these general scientific skills, doctoral candidates should develop disciplinary (for example, working in laboratories requires the ability to handle certain equipment such as a centrifuge) as well as interdisciplinary skills (for example, in interdisciplinary writing, when researchers need to handle challenges in finding a fitting journal when ideas of different discipline cultures together lead to new styles of articles (for example, in investigating doctoral education from subject educational, psychological, and sociological perspectives)) (Berning & Falk, 2006; Doody, 2020; Enders, 2005). These skills are relevant beyond the German context as shown by a study on required skills for applications to postdoctoral positions (Mantai & Marrone, 2023).

As a general basis for scientific career paths, doctoral candidates should develop a scholarly identity. Scholarly identity as a facet of professional identity means that doctoral



candidates identify themselves as researchers (Pyhältö, Nummenmaa et al., 2012) (see section 1.3.2). Here, it should be noted that beyond official formal requirements doctoral candidates have to fulfill (for example, publishing their doctoral thesis (GSHC, 2011a)), there are several informal requirements they have to meet for their personal development as researchers. Informal developing and learning according to their own personal, social, and psychological needs besides their academic needs are considered in a hidden curriculum (Elliot et al., 2020). Doctoral candidates have to manage autonomously both formal and informal requirements for successfully finishing their studies and for the most efficient learning outcome. Additionally, further agents in doctoral education (like supervisors and mentors) can support the candidates in informal learning mechanisms (Elliot et al., 2020).

A doctoral degree is both a basic qualification for academic positions at universities and beneficial for many different employments outside academia (BuWiN, 2021; Dumpitak et al., 2014; GSHC, 2023; Krempkow, 2010). For example, doctoral graduates in the life sciences might work in pharmaceutical industries, economic research, in hospitals, schools, for publishers and others. Therefore, doctoral education should include key competences (like team-work) and competences for practice and non-academic employments as well (Berning & Falk, 2006; Nerad, 2008).

In Germany, there are two main formats of doctoral education—the traditional master-apprentice model and *structured doctoral training programs (doctoral programs)*. In the traditional master-apprentice-model, usually, one professor supervises the doctoral candidate during their whole doctoral studies optionally supported by one or more postdoctoral researchers. Most of doctoral candidates finance their doctoral studies through employment at universities or non-university research institutes (BuWiN, 2021). However, there are some points of criticism on the master-apprentice model: besides the great dependence on individual relationships between doctoral candidates and their supervisors, higher education policy criticizes a lack of quality-control, and doctoral studies take varying lengths of time (Kehm, 2006). Additionally, requirements for an application process are often not clearly stated if there is an application process at all (Enders, 2005). Examining doctoral theses by the supervisors could lead to a potential conflict of interest when supervisors evaluate their own monitoring of monographic doctoral thesis or their own research in joint published research articles which serve as basis for paper-based doctoral theses (GSHC, 2011a, 2023). Doctoral candidates often report problems in developing field-specific expertise (like learning complex techniques), being embedded in the scientific community, and financial resources for their doctorate (Pyhältö, Toom et al., 2012; Walker, 2008). Furthermore, doctoral candidates are rarely trained in

teaching research (Nerad, 2008). To improve doctoral education, doctoral programs are increasingly implemented (HRK, 2012). Currently, almost half of the German doctoral candidates are enrolled in such programs (GSHC, 2023). In doctoral programs, usually, doctoral candidates are financed by funds of the joined doctoral program and they can mostly attend several course offerings as formal learning opportunities on various topics (including subject-specific and interdisciplinary courses) (Berning & Falk, 2005, 2006; Enders, 2005; Fiedler & Schedel, 2009; GSHC, 2023; Hornbostel & Simon, 2010; Nerad, 2008). Furthermore, supervision is increasingly structured through specified rights and obligations of both supervisors and doctoral candidates in supervision agreements (Berning & Falk, 2004; GSHC, 2011a). A *thesis advisory committee (TAC)* complement supervision by the professor as supervisor (GSHC, 2023). Additionally, application processes are suggested to be transparent and competitive (GSHC, 2023). There are various forms of doctoral programs—they range from doctoral programs, which determine the general structure of doctoral studies independently from disciplines and research topic (like graduate schools) to doctoral programs, which offer doctoral studies on a specific topic within a discipline or interdisciplinary (like the *Integrated Research Training Group (IRTG)* “Dynamic Hydrogels at Biointerfaces” (IRTG Website)). Yet, the lack of a consistent definition of doctoral programs results in difficulties when different statistical surveys are compared (GSHC, 2023). Additionally, structure of doctoral education does not depend on a simple distribution in the traditional master-apprentice-model and doctoral programs (Lachmann et al., 2020; Martius et al., 2014). In Germany, academia increasingly improves the traditional master-apprentice-model with structuring elements (such as introducing supervision agreements and optional course offers). Besides the master-apprentice-model and doctoral programs, there are currently several hybrid approaches in between (GSHC, 2023; Schneijderberg, 2018). Meanwhile, GSHC warns that high levels of structure during doctoral education may put developing autonomy and self-responsibility of doctoral candidates at risk. Therefore, structuring doctoral studies is reasonable only to a certain extent in order to improve doctoral education (GSHC, 2023).

### 1.1.2 Postdoctoral research

After doctoral graduation, life science researchers who want to stay in academia work as *postdoctoral researchers (postdocs)*. In the transition from doctoral studies to postdoctoral research, there is a high drop-out rate since most doctoral graduates reported that they did not conduct research (BuWiN, 2017; Flöther, 2017). Postdocs who want to stay in academia strive for further qualification in this second qualification phase: some postdocs conduct research for their habilitation. However, besides habilitation, habilitation-equivalent achievements (such as

further published articles after doctoral graduation) become increasingly important as a prerequisite for an appointment as a professor (GSHC, 2014). Furthermore, postdocs qualify in managing projects and raising third-party funds independently, in research-related infrastructure, in science management, and in transfer of knowledge and technology. A further qualification is teaching as a central part in postdoctoral employments in academia (BuWiN, 2021; GSHC, 2014). Another request for successful transition to postdoc-positions is mobility (the willingness to move and for stays abroad) (GSHC, 2014). Almost half of German postdocs conducted research in a stay abroad for more than three months (BuWiN, 2017). Postdoctoral research in the life sciences is mostly characterized through interdisciplinary cooperation and industry collaborations (BuWiN, 2021).

This phase is further characterized by the following dilemma: the longer researchers remain at university as postdocs, the worse perspectives for equivalent positions outside academia get. Thus, they are at risk if they decide to take another fixed-term position as postdoc at the same or a different university (GSHC, 2014). Meanwhile, their days in academia are limited by law. In Germany, the law on the duration of fixed-term contracts in academia called *Wissenschaftszeitvertragsgesetz (WissZeitVG)* limits employment durations of researchers in academia to twelve years in sum—six years for doctoral studies and further six years for additional qualification (habilitation or habilitation-equivalent achievements). Exceptions are made to these strict deadlines in the case of parental leave (for each child, time is extended by two years), for medical researchers (after doctoral graduation, they can further qualify in nine instead of six years) and during the COVID-19-pandemic (Regulation on WissZeitVG, 2020; WissZeitVG, 2016). After the current discussion on insecure career paths in academia, German policy is about to launch a reform of this law (see section 1.2).

### 1.1.3 Independent research

Reaching the next career stage as independent researchers, postdocs can take increasingly responsibilities as preparation for later potential professorship positions, for example, through performing research management tasks and leading groups of junior researchers. In Germany, postdocs can get a position as (i) junior research group leader, (ii) a junior professorship position with or without tenure-track or (iii) a tenure-track professorship position (BuWiN, 2021). (i) Mostly one to four years after doctoral graduation, postdocs can take a position as junior research group leader. With such positions, academia tries to foster eligibility for appointment to a professorship position without habilitation (BuWiN, 2021; DFG, 2021). Holding a position as junior research group leader, German postdocs mostly teach 2.6 semester hours on average besides their research (BuWiN, 2017). Another form of independent research is (ii) a junior

professorship. Extending the profile as a researcher through increasingly independent research, teaching responsibilities, participation in academic administration, and appropriate equipment for research define this position (BuWiN, 2021). Some junior professors have a permanent position in prospect once their fixed-term contract has expired (tenure-track). However, most junior professorship positions do not have a tenure-track-option and appointment to a permanent professorship position depends on availability of such a position once the contract as junior professor has expired (BuWiN, 2021). In contrast to junior research group leader, German junior professors teach to a considerably greater extent in addition to their research (5.6 semester hours on average) (BuWiN, 2017). In the third form of independent research, (iii) tenure-track professors conduct autonomous research and teach students mostly limited for six years with a permanent professorship position in prospect after a final evaluation. When getting appointed to a tenure track-professorship position, candidates and the respective university negotiate obligatory achievements required for final evaluation (GWK, 2016). With increasing leading responsibilities in independent research, postdocs conduct research as *principal investigator (PI)*.

### 1.1.4 Professorial research

Finally, researchers who want to stay in academia on the long run typically strive for a permanent appointment as a professor. Although the number of appointments slightly increased since the nineties, there had been still more than 22 more applications for professorship positions than appointments in 2018 (BuWiN, 2021). Mostly, habilitation or habilitation-equivalent achievements are the relevant requirements for the appointment as a professor besides a plurality of other possibilities (see section 1.1.3). In Germany, most appointed professors possess both doctoral degrees and habilitation especially in the life sciences (BuWiN, 2021). In medicine, researchers need to work practically as physicians in addition to their scientific activities in order to have a good chance to get an appointment as a professor (Medical Faculty of the LMU). Research and patientcare are strongly linked during medical academic research careers (Epstein et al., 2016; Loos et al., 2014). Professorial researchers conduct independent scientific research as PIs (Höhle & Teichler, 2016). Furthermore, professors have to teach. Besides academic achievements (published articles, fundraising, among others), important attributes in applications for independent and professorial research positions are entrepreneurial skills and experiences (such as applying for patents) as well as professional teaching and supervising skills (Mantai & Marrone 2023). In sum, pressure in taking the next step in the career ladder in a determined timespan characterizes the highly competitive academic research career path (Kwiek & Antonowicz, 2015).

On the basis of the brief insight in a prototypical academic research career path considering particularities of life sciences in Germany, further institutional conditions (see section 1.2) and their underlying structural antecedents in academia from a national and international perspective are presented in the following sections (see sections 1.2.1-1.2.2).

## 1.2 Structural key issues in academia

In the following, key issues in academia are explained in-depth as institutional conditions relevant in academic research careers. Furthermore, structural antecedents are briefly described including research on academic research careers (section 1.2.1) and recommendations of policy (section 1.2.2) influencing these institutional conditions.

In Germany as well as internationally, challenges in academic research careers are a widely debated issue (BuWiN, 2021; Kehm, 2006). Besides criticisms on doctoral education (see section 1.1.1) (1) precarious working conditions in daily research and (2) highly insecure career paths in academia were criticized as described in the following.

There are (1) precarious working conditions shaping daily research. Scientific staff at universities have to perform in various tasks: basically, they have to teach students besides their research. Additionally, many administrative tasks arise in both sectors—teaching and research (such as online administration of offered courses for students and managing project funds) (Åkerlind, 2009; Teichler et al., 2013). In Medicine, researchers have almost three duties: patient care, research, and teaching (the so called “Dreifachbelastung” (in English: triple strain)) (Loos et al., 2014). The high number of tasks often results in research and publication of research taking place outside normal work hours (the so called “Feierabendforschung” (in English: after work research)) (GSHC, 2004). One-third of early career researchers is employed part-time (BuWiN, 2021). But researchers have an enormous workload in order to fit the various roles. Consequently, most researchers work more than working hours agreed on in Germany (BuWiN, 2021). Furthermore, there are debates about gender discrimination in academia (Gibney, 2019)—especially about discrimination of women (Carr et al., 2000). In Germany, both the number of women and the number of female appointed professors increased since the nineties (BuWiN, 2021). Nevertheless, fewer women than men work as scientists overall, especially in leading positions. The so called “leaky pipeline” shows that the number of women researching in academia decreases with higher qualifications in leading positions (BuWiN, 2021). Additionally, more women than men work part-time for childcare or similar (BuWiN, 2021; Destatis, 2019; Flöther & Oberkrome, 2017; Weber & Zimmert, 2018).

(2) Career paths in science are highly insecure owing to (a) frequent fixed-term contracts and (b) lacking permanent positions. Mostly, (a) contracts of university employees are fixed-term (BuWiN, 2021; Höhle & Teichler, 2016). Universities have to explain why a fixed-term contract is appropriate. One reason for fixed-term employment could be a certain qualification (like doctoral studies, habilitation or habilitation-equivalent achievements) or working in a project which is funded by third-parties (WissZeitVG, 2016). In Germany, higher education

policy reasons necessity of fixed-term contracts with the argument, for example, that only new employees in academia can research on new topics. Bahr and colleagues (2022), summing up the #IchbinHanna-discussion on Twitter, question this argument and adduce inefficiency of research in Germany on the basis of frequent periods of orientation when new researchers start their fixed-term employment in academia. When newcomer in research need around one year for orientation on average, then there is not much time left for innovative research in a contract that is usually limited to two years (Bahr et al., 2022; Krempkow, 2022; BuWiN, 2021). Currently, politicians discuss some arguments of the #IchbinHanna-movement and intend to reform the WissZeitVG again. Since modification of the revised WissZeitVG from 2016 was not sufficient, the *Federal Ministry for Education and Research (BMBF)* presented a further revised draft of the WissZeitVG in June 2023. For example, the new draft sets the minimum contract term at two years and reduces contract periods for postdocs from six down to four years (BMBF draft bill, 2023). However, there has already been a discussion whether the changes will address and change the urgent issues (e.g., [www.wissenschaft-verbindet.de](http://www.wissenschaft-verbindet.de), 2023). Therefore, future research should monitor further developments related to the WissZeitVG in academia as one example of the structural antecedents' influence on institutional conditions. Currently, doctoral candidates are employed with contracts for 22 months while postdocs are fixed-termed employed for 28 months on average (BuWiN, 2021). Sometimes, further employments of scientists are only possible when they seek their own payment by raising further external funds (Kwiek & Antonowicz, 2015; Torka, 2006). Internationally, raising funds is highly competitive (Woelert et al., 2020). Research in projects, financed by external funds, causes insecurity in academia because acceptance and financing of projects is difficult to plan ahead in the highly competitive academic system (Jaksztat et al., 2010). Furthermore, (b) a sufficient number of permanent positions is lacking. For fostering more predictable, transparent and, thus, international competitive academic research career paths in Germany, universities introduce comprehensively fixed-term positions mostly with a permanent position in prospect (such as junior professorships with or without tenure-track, tenure-track-professorship positions) (BuWiN, 2021; GWK, 2020). Currently, in Germany, policy finances the introduction of further 1000 tenure-track-professorship positions in a nationwide program (2017-2032) resulting in increasing numbers of researchers employed in tenure-track-professorship positions (BuWiN, 2021; GWK, 2016; GWK Website). Tenure-track positions should enable junior researchers to make a final decision to stay in academia earlier (GWK, 2020). Additionally, more permanent positions for mid-level academics conducting scientific management, teaching, among other tasks as an alternative academic career path besides

professorship positions are discussed (GSHC, 2014; Jaksztat et al., 2010). In sum, there is still a need for more contracts of indefinite durations (BuWiN, 2021; Krempkow et al., 2014). Still, some talented and qualified scientists have to search for an employment outside academia after they could not receive any positions of indefinite duration in the highly competitive academic system. These scientists, who cannot take the next academic career step are forced to leave academia because of the German WissZeitVG. However, employments for life scientists (especially for biologists) in and outside of academia are rare (Jaksztat et al., 2010; Klöck, 2010; Plasa, 2014) while some life scientists (such as physicians and chemists) have attractive employment opportunities outside academia (Plasa, 2014). Although the number of vacant professorship positions in Germany increased (BuWiN, 2021), a sufficient number of such positions is still lacking regarding the increasing number of early career researchers (BuWiN, 2021; Krempkow et al., 2014). A participants' comment on the cross-sectional survey points out individual consequences of insecure career paths when an experienced scientist is no longer allowed to be employed in academia because the years as postdoc are expired:

“After 18 years as a postdoc with fixed-term contracts and periods of self-funding through collaborations with industry, I am no longer employed owing to the [WissZeitVG] law, although funding and projects are available. At over 50, I am facing the end [of my career], as it is extremely difficult to change my job at this age.”<sup>4</sup>

At German medical faculties, there is another issue leading to potentially problematic career paths. Besides students of medicine and dentistry, students with other backgrounds (biology, psychology, among others) can complete their doctoral studies and continue their scientific career at medical faculties. However, scientists who have not graduated in medicine mostly cannot be hired as professors because basic studies in medicine or dentistry are necessary requirements for some medical professorship positions. For example, during the application process for a clinical professorship position at a German medical faculty, clinical experiences are required which a non-medical applicant cannot have (Medical Faculty of the LMU). Nevertheless, non-medical doctoral graduates can be appointed to some preclinical professorship positions (such as biologists in biochemistry).

Insecure career paths and precarious working conditions for researchers at universities as institutional conditions may promote dissatisfaction, drop-out intentions, and drop-out decisions of researchers as indicated by high drop-out rates already during the doctorate (BuWiN, 2017, pp. 155-157; Kehm, 2006) as well as in later career stages after doctoral graduation (BuWiN, 2021; Jaksztat et al., 2010). However, structural antecedents are associated with institutional conditions (see section 1.). Therefore, previous research and

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<sup>4</sup> I translated the comment from German into English.



recommendations of policy on improving institutional conditions in academia are presented in the following sections.

### 1.2.1 Research on academic research careers

Resulting from criticisms on institutional conditions in academia, there are many investigations on academic research careers. Here, a brief overview of internationally and nationally relevant studies on academic research careers is provided.

In Germany, the BMBF regularly orders reports about conditions in academia for junior researchers (e.g., BuWiN, 2017, 2021). Thereby, urgent problems of academia in Germany are named and statistically documented at regular intervals. In 2017, precarious conditions in academia regarding common fixed-term contracts and insecure career paths, because permanent positions are lacking, were described (BuWiN, 2017). However, within BuWiN (2021), the report had already described a nationwide initiated tenure-track program and a revised framework for fixed-term contracts within the *WissZeitVG* (see section 1.2). Reports of the BMBF draw upon several other empirical investigations such as on the *National Academics Panel Study (NACAPS)* and the *WiNbus-study*. NACAPS investigates career paths of doctoral candidates and doctoral graduates as panel-study (NACAPS Website). Researchers of the *WiNbus-project* collected data on perceiving and rating Germany as a science location in regular surveys (WiNbus Website). Furthermore, there are several institutions regularly monitoring developments in academic research careers (like the Institute for Innovation and Technology, Bavarian National Institute for Higher Education Research and Planning, INCHER Kassel (International Centre for Higher Education Research Kassel), DZHW (German Centre for Higher Education and Science Research), Institute for Higher Education Research HoF, Destatis (Federal Office of Statistics) (BuWiN, 2017)). Additionally, there are several smaller studies on academic research careers of single university departments like the study on doctoral studies in Germany conducted by the *Center of Leadership and People Management (CfLPM)* of the *Ludwig-Maximilians-Universität München (LMU)*. This study, which had been selected as an example, focuses on attitudes towards a dissertation, motives for starting and continuing doctoral studies, and experiences during examining doctoral studies (CfLPM Website). Furthermore, the interdisciplinary project *E-Prom* of several German universities investigated influencing factors on career paths in the life sciences (see section 2.). This doctoral study is embedded in the *E-Prom-project* and reports analyses of subsamples drawn from the project-datasets. Previous research of the interdisciplinary *E-Prom-team* had already examined some individual factors (such as research-related self-efficacy, factors of success or failure, integration in scientific communities, gaining scientific competencies,

motives for conducting doctoral studies, academic career aspirations, and social capital) as well as institutional conditions during doctoral studies (such as supervision, formal criteria of the doctorate, and scientific productivity) (Epstein, 2016; Epstein & Elhalaby, 2023; Epstein & Fischer, 2017; Epstein & Lachmann, 2018; Epstein et al., 2018; Epstein et al., 2016; Epstein et al., preprint; Lachmann et al., 2020; Lachmann et al., 2018; Martius et al., 2014; Mozhova, 2018). These previous investigations of life scientists' academic research careers focusing on research-related variables had already suggested complex interactions between various individual factors and institutional conditions related to academic career paths (Epstein et al., resubmitted). In addition to previous examinations of the *E-Prom*-team, more recent data and further individual and institutional factors were included in the analyses and the results were embedded within the eRCCF compiled by psychological theories in this doctoral thesis (see section 1.). Beyond the presented research, there are various further studies on junior researchers in German academic systems not reported here in detail (e.g., Berweger, 2008; Berweger & Keller, 2005; Briedis et al., 2014; Schneijderberg, 2018).

Internationally, there are various approaches for examining determinants of academic research careers, too (Cañibano et al., 2019; Woolley et al., 2016). There are different models for investigating drop-out and career decisions in academia primarily from a sociological perspective (for example, on the basis of the *Social Cognitive Career Theory (SCCT)* of Lent and colleagues (1994)) (e.g., Berweger, 2008; Gläser, 2001; Woolley et al., 2016). Each model focuses on different variables for explaining career decisions. In the following, a brief overview of models and the examined variables is presented exemplarily: Gläser and Laudel examined characteristics of the researchers including, for example, motivation and other agents interacting with the researchers at different career stages (Gläser, 2001; Gläser & Laudel, 2007; Laudel & Gläser, 2008). Another model investigating academic career paths focused on researchers' human capital relevant for career paths and scientific knowledge production. For example, research collaborations, scientific communities, and institutional conditions such as funding had been examined (e.g., Bozeman et al., 2001; Bozeman & Rogers, 2002). Another well-investigated factor in academic research careers is researchers' mobility (e.g., Woolley et al., 2009). Cañibano and colleagues (2019) developed the RCCF for bridging differences in these research approaches. They considered both individual and institutional factors influencing decisions for or against pursuing a research career (see section 1.). Furthermore, some studies compared institutional conditions in academia shaping career trajectories in different countries (e.g., Kaulisch & Salerno, 2005). Owing to gender differences as a key issue in academia (see section 1.2), some models focused on gender as a further factor influencing academic research

careers (e.g., Abele, 2002; Berweger, 2008). Woolley and colleagues provided an overview of models, variables, and research projects on academic career decisions in their literature review (Woolley et al., 2016). Furthermore, there are some European efforts for unifying studies on academic research careers (for example, through agreement on four stages of a typical academic research career) (EC, 2011; ESF, 2012). Previous research provided evidence for the relevance of both institutional and individual factors in academic careers. International research on institutional factors (like the availability of further academic employments or academic outputs) as well as on researchers' experiences in academia (like work related stress, relationships within scientific communities, self-efficacy, and identity facets) supports assumptions of the eRCCF (Allmendinger et al., 2000; Berweger, 2008; BuWiN, 2021; Dorenkamp & Weiß, 2018; Epstein, 2016; Epstein & Fischer, 2017; Frick et al., 2016; Kwiek & Antonowicz, 2015; Lally & Kerr, 2005; Lindahl et al., 2020; van Balen et al., 2012). However, previous studies on academic research careers focused mainly on either institutional determinants of career paths or individual experiences shaping careers in academia (Cañibano et al., 2019). Beyond the described research on academic research careers, individual and institutional factors as well as their antecedents are considered in explaining career paths in academia in this dissertation. For discussing results of this thesis and embedding them in up-to-date research, the RCCF of Cañibano and colleagues (2019) was extended to the eRCCF and serves as conceptual framework for interpreting the results (see figure 1).

### **1.2.2 Recommendations of policy for improving academic research careers**

Owing to the criticism on academic research career paths and working conditions (see section 1.2) and on the basis of many studies on academic research careers (see section 1.2.1), higher education policy recommends improvements for academic research careers.

In Germany, for example, the GSHC and the *German Rector's Conference (HRK)* publish regularly some recommendations on current key issues in academia. Furthermore, the BMBF navigates institutional conditions in academia through laws (like the *WissZeitVG* managing conditions of fixed-term contracts in academia) (see section 1.2). In order to facilitate scientific work, the GSHC publishes statements and recommendations on various topics related to institutional conditions in academia throughout qualification and career stages: besides publications on basic studies, reviews on the status quo in specific research fields, or recommendations on improving infrastructure of information (archives, libraries) among others, recommendations for improving academic research careers are a key issue for the GSHC (GSHC Website). For example, the GSHC mentioned in 2023, that supervisors of doctoral candidates still review the supervised doctoral thesis as first examiner despite potentially

reduced objectivity. Therefore, the GSHC suggested that a second examiner (preferably an external examiner) review the thesis independently from the first examiner (GSHC, 2023). The HRK demanded for introducing doctoral programs in order to improve doctoral education for example (HRK, 2012) (see section 1.1.1). Internationally, there are efforts for improving academia as well. For example, in the United States of America, there are several initiatives demanding for improvement of doctoral education ('Carnegie Initiative on the Doctorate'; 'Graduate Education Initiative') (Nerad, 2008; Schneijderberg, 2018).

In sum, working in academia on the long run is a risky career path and unpleasant working conditions can hamper academic research careers despite recommendations of policy for improvement. However, beyond institutional conditions and structural antecedents associated with career decisions, individual preferences and individual-level antecedents are related to career decisions in academia as well (see section 1.). Psychological theories on basic psychological needs (see section 1.3.1), identity (see section 1.3.2), and emotions (see section 1.3.3) explaining relevant individual-level antecedents and individual preferences in academia are presented in the following.

### 1.3 Researchers' individual-level antecedents in academic research careers

Academic research careers may be a risky life plan (see section 1.2). Progress in career paths depends, for example, on opportunities and chances when a suitable position in academia is available at a desired location (e.g., Ortlieb & Weiss, 2018). However, the question arises, what keeps scientists in academia despite such hurdles and insecurity as institutional conditions. The quote in the introduction gives a hint that affective factors such as attitudes, emotionality, and passion may play a role in pursuing academic career paths despite potential risks (see section 1.). Supporting this assumption, proximal individuals' experiences are related to drop-out intentions in academia beyond distal institutional factors (e.g., Reason, 2009). Thus, individual factors seem to be relevant in academic career decisions as well. Individual factors include both individual preferences (such as career aspirations) and individual-level antecedents (such as basic psychological needs support, identity, and emotions) related to such preferences which are key factors in explaining career decisions (e.g., Cañibano et al., 2019; Litalien & Guay, 2015; Lally & Kerr, 2005; Ortlieb & Weiss, 2018). In the following, psychological theories describing details of the individual-level antecedents, investigated in this doctoral thesis, are presented. It should be considered that single theories and variables were chosen to capture researchers' experiences best. However, there are some more individual-level antecedents associated with career aspirations and decisions (the willingness of the family to move again or not when the position is in another city, county or country, social capital, self-attribution of previous scientific success, willingness to spend time in networking and research, among others (Epstein & Elhalaby, 2023; Fernández-Zubieta et al. 2015; Ortlieb & Weiss, 2018; Sumell et al., 2009)).

For investigating individual-level antecedents shaping academic research careers in more detail, three theoretical approaches are presented which facilitate gauging researchers' experiences in academia. First, theoretical assumptions on basic psychological needs within the *Self-Determination Theory (SDT)* on motivated behavior are explained (see section 1.3.1). Basic psychological needs are assumed to be universal (Vansteenkiste et al., 2020) and the three basic psychological needs of autonomy, competence, and social relatedness are in alignment with central aspects of academic research careers. Therefore, it seems to be reasonable to gauge complexity of the social environments' impact in academia on researchers' experiences with a SDT-approach: autonomy is the guiding idea of independent research (for example, when postdocs raise external funds on their own and, thus, extend their research profile as an increasingly independent researcher (see section 1.1.2-1.1.3)) (GSHC, 2011a, 2011b; Henkel, 2005). In highly competitive academia, competence is another central factor (for example, when

researchers get the reviewers' feedback on their research and writing competence during submission processes) (GSHC, 2011b). Lastly, today's research is increasingly cooperative and interdisciplinary. Therefore, social relatedness is a further crucial factor in academia (for example, when scientists successfully conduct research through cooperating with other scientists as well as when they gain further attractive positions owing to a sufficient network to other relevant scientists (Doody, 2020; Gläser, 2012; Kyvik, 2013)). Second, description of scholarly identity as the identity facet relevant in academia is embedded within previous research on professional identity (see section 1.3.2). Developing scholarly identity is one central aim of doctoral studies (see section 1.1.1) and it is associated with several outcomes (like vocational behavior and decisions, aspiring a career path) which may influence career paths (Brownell & Tanner, 2012; Lally & Kerr, 2005). Lastly, the Control-Value Theory on achievement emotions is described (see section 1.3.3). Competition in raising funds, publishing articles, getting the desired permanent position as well as in further situations in academia imprint academic research careers (e.g., Mantai & Marrone, 2023). Since passing in academia can be seen as a prototype of achievement situation as described by Pekrun (2006), Control-Value Theory seems appropriate to gauge affective experiences of researchers (for example, to measure a biologist's enjoyment when a successfully conducted long-term experiment results in analyzable data).

### 1.3.1 Self-determination Theory

In this section, a brief overview of SDT-assumptions and their value to gauge experiences in academia is elaborated. SDT is an organismic dialectic approach. It relies on the assumption that individuals try to develop a coherent self-concept driven by intrinsic motivational factors (organismic). However, there are relationships between the self and external factors of the social environment supporting or hindering this tendency (dialectic) (Deci & Ryan, 1993, 2002). SDT as a motivational theory states, in general, that individuals should be able to act self-determined for being intrinsic motivated. Intrinsic motivation and self-determination lead to healthy development of personality and well-being (Deci & Ryan, 2002, 2012b; Luyckx et al., 2009). SDT sums up five mini-theories connected via the concept of *basic psychological needs* (*basic needs*) as well as organismic and dialectal assumptions (Deci & Ryan, 2002). There are three universal basic needs: the need for autonomy implies that people want to think and behave self-determined (Vansteenkiste et al., 2020). The need for competence means that people want to perceive themselves as successful or want to learn how to feel successful in a next try (Vansteenkiste et al., 2020). The need for social relatedness includes that people want

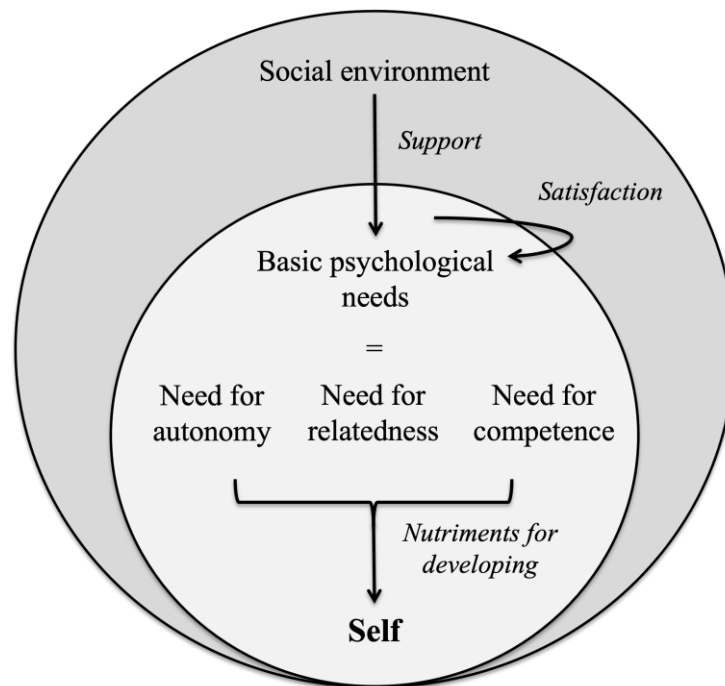
to feel embedded in social relevant groups (for example, in the group of colleagues at work) (Vansteenkiste et al., 2020).

In the following paragraphs, brief descriptions of the five mini-theories illustrate SDT as background. Afterwards the *Basic Psychological Needs Theory* is focused (see figure 3): in the (1) *Cognitive Evaluation Theory*, researchers identified supporting and hindering effects of the social environment on intrinsic motivation. For example, feedback on behavior informs the recipients on their level of competence. Furthermore, feedback controls behavior and thwarts autonomy of the recipients. With supporting autonomy and competence, intrinsic motivation increases (Deci & Ryan, 2012b).

Researchers of SDT identified in the (2) *Causality Orientations Theory* three causality orientations to explain various psychological outcomes (like self-esteem). If people orient themselves self-determined toward internal and external values, they are autonomous causality oriented. However, controlled causality orientation implies that people feel pressure to follow internal and external values as controlling demands. At least, impersonal causality orientation means that people perceive information as a sign of their own incompetence. These people are generally amotivated (Deci & Ryan, 2012b).

Regarding people's life goals, researchers derived the (3) *Goal Content Theory* on the relevance of extrinsic and intrinsic life goals for several outcomes (such as well-being). Pursuing external aims like wealth mostly hinders need satisfaction and can lead to less well-being. Whereas, internal aims like becoming a physician in order to help sick people may enhance well-being (Deci & Ryan, 2012b).

In the (4) *Organismic Integration Theory* researchers defined a continuum of motivation on the basis of the assumption that individuals internalize experiences in and values of social environments. It ranges from intrinsic motivation to extrinsic motivation, which differ in the type of regulation. Extrinsic motivation is divided into four subgroups differentiated by the type of regulating behavior. External regulation indicates that individuals will behave in a specific way caused by external factors. Introjected regulation means that behavior is caused by internal factors, which are still separated from the self. With identified regulation, individuals act in a specific way because they highly value the purpose of the action. Integrated regulation implies that the causes for behavior are integrated in the self-concept. At the other end of the continuum, intrinsic motivated behavior is caused by an internal intention of the self (Deci & Ryan, 1993, 2002). Support of basic needs facilitate the process of internalization of the values and factors (Deci & Ryan, 2012b). However, amotivated behavior is not caused by any intention (Deci & Ryan, 1993, 2002).



**Figure 3. Overview of assumptions of BPNT (based on Deci & Ryan, 2002, 2012b).** The social context supports basic needs (need for autonomy, competence, and social relatedness). Satisfaction of these needs delivers nutriments for developing a coherent and healthy self-concept.

The three basic needs are a basic assumption of and connect the mini-theories within SDT. Research on the (5) *Basic Psychological Needs Theory (BPNT)* highlight the relevance of the need for autonomy, competence, and social relatedness for overall well-being and identity development (Deci & Ryan, 2012b; Luyckx et al., 2009). The social environment can support individuals in their basic needs. Though individuals feeling competent, autonomous, and socially related to relevant groups are more likely to feel well and develop a stable self (Deci & Ryan, 2002; 2012b) (see figure 3). There is evidence for their validity in several contexts like vocation (e.g., Olafsen et al., 2018), school (e.g., Vallerand et al., 1997), and higher education (e.g., Vermote et al., 2020). Research on BPNT emphasizes the influences of the social environment supporting basic needs on wellness, aspirations to pursue a specific career path, and emotional experiences (Deci & Ryan, 2012b; Flunger et al., 2013; Litalien & Guay, 2015). Besides previous research on SDT in general higher education (e.g., Vermote et al., 2020), some studies had already applied the concept of basic needs to the context of doctoral studies (e.g., van der Linden et al., 2018). However, empirical evidence for the validity of basic needs at later career stages is lacking. Nevertheless, basic needs seem to be useful to capture researchers' experiences in academia as individual-level antecedents of career decisions for several reasons: research at all stages of a scientific career can be assumed as learning situations since doing research implies exploring and learning completely new things. Therefore, competence is a



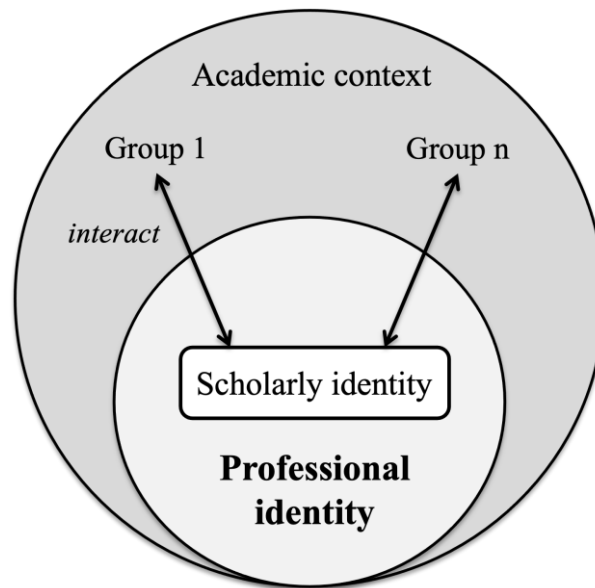
central value. Researchers want to show their research skills when they successfully publish articles, raise funds or hold discussions during a paper presentation of a conference. Autonomy is another central value in both SDT and academia (Henkel, 2005; Vansteenkiste et al., 2020). Self-determined conducting research is a classical ideal in academia and a central aim of doctoral education (GSHC, 2011a, 2011b) (see section 1.1.1). At least, scientific research is shaped through networking and collaborations with other researchers (Gläser, 2012; Kyvik, 2013), thus, social relatedness is another crucial value in academia. In academia, there are several relevant communities shaping research experiences (Devos et al., 2017). One central group is the scientific community of researchers linked by similar research interests as a community of practice (Kienle & Wessner, 2005). The scientific community plays an important part in acknowledging independent scientific research (for example, in review processes for publishing research in scientific journals) (GSHC, 2011b). Although autonomous research is frequently conducted in research teams including collaborations and a certain interdependence of other researchers, autonomy and social relatedness is not contradicting each other. Mostly, other researchers are heavily involved in confirming competence in academia when, for example, experts of a specific research topic provide feedback on a manuscript during a peer review of journal articles or an application for external funds (Vekkaila, 2014). Nevertheless, SDT assumes the need for autonomy, competence, and social relatedness to be separated factors (Deci & Ryan, 2002; 2012b). Considering previous research results and theoretical assumptions, the three basic needs seem to represent researchers' experiences in the academic social environment quite well. Furthermore, basic needs support is associated with other relevant individual-level antecedents, such as identity and emotions, and with career aspirations as individual preferences as defined by the RCCF (Cañibano et al., 2019; Flunger et al., 2013; Litalien & Guay, 2015; Luyxck et al., 2009). Therefore, investigating researchers' perception of basic need-supportive social environments in academia in this doctoral study seems beneficial for examining researchers' experiences as individual-level antecedents in order to explain their career decisions within the eRCCF.

### **1.3.2 Professional Identity**

Identity is a further relevant individual-level antecedent. Developing an identity is a central aim in doctoral education (see section 1.1.1) and crucial experiences of researchers (related to their competence, autonomy, and social relatedness) are associated with developing a stable identity (Luyxck et al., 2009). To capture identity in the special context of academic research careers, the identity facet of scholarly identity embedded in previous research on professional identity is elaborated in the following.

In general, identity development lasts a whole lifespan because individuals are constantly having new experiences that need to be reconciled with an existing identity-concept and integrated into various aspects of identity (Deci & Ryan, 2012a; Skorikov & Vondracek, 1998). In vocational contexts, professional identity is relevant since vocation became a crucial factor for individuals' self-fulfillment. Identification with a profession becomes more and more important as the roles of work and profession have changed in society. Baumeister and Muraven (1996) stated that in medieval Christian society, people mostly worked because religion said it is their duty. After secularization, work had to be increasingly justified with alternative aspects. Nowadays, people perceive their jobs as important for flourishing and developing an identity (Baumeister & Muraven, 1996, p. 411). Professional identity is a dynamic construct developing through reciprocal interactions with members of the social environment. Individuals compare previous and current forms of their professional identity and develop a vision of their future professional self (Park & Schallert, 2020). Previous research investigated professional identities in various contexts like schools (e.g., Beijaard et al., 2004), higher education (e.g., Trede et al., 2012), and doctoral education (e.g., Park & Schallert, 2020). Professional identity influences several outcomes such as the aspirations for specific actions and vocational decisions (Brownell & Tanner, 2012).

In academia, as a special vocational context, passionately conducting research and self-fulfillment within meaningful research are common reasons for pursuing a stressful and insecure career in academia as the enthusiasm of the quote from the beginning hints (see section 1.). In this context, scholarly identity is the relevant facet of professional identity. In line with assumptions of professional identity, scholarly identity means adapting and internalizing research traditions and norms of a specific discipline. During an identification process, individuals determine their own definition of what it means to be a researcher (Pyhältö, Nummenmaa et al., 2012). During everyday research, scholarly identity further develops when researchers communicate about research or join relevant groups and communities (Mantai, 2017; Cai et al., 2019). As outlined in figure 4, previous studies emphasized that researchers dynamically identify with the academic profession through frequently interactions with a variable number of other scientists and communities of scientists (Park & Schallert, 2020; Pyhältö, Nummenmaa et al., 2012).



**Figure 4. Scholarly identity as a facet of professional identity in academia as a vocational context (based on Castelló et al., 2021; Pyhältö, Nummenmaa et al., 2012).** Researchers develop their scholarly identity through frequent social interactions with other scientists in their social environment.

Castelló and colleagues (2021) reviewed previous research on identity of scientists. The idea of scientists' identity was not used consistently. Therefore, Castelló and colleagues (2021) differentiated four dimensions in which identity constructs can be located. First, they distinguish between identities shaped only by individuals themselves and identities defined by social environments. The second dimension provides a distinction between a stable and a dynamic identity. The third dimension ranges from a single identity to various competing identities within a single person. Lastly, identity can be defined through thinking or acting (Castelló et al., 2021). Within these dimensions, scholarly identity can be located as a dynamic identity facet of a single identity which is shaped by various social interactions especially with scholarly communities (Castelló et al., 2021; Pyhältö, Nummenmaa et al., 2012). Owing to evidence on the associations of identity and aspiration of a specific career path (Lally & Kerr, 2005), scholarly identity as the relevant professional identity facet in academia can be assumed to be a further individual-level antecedent of career decisions within the eRCCF.

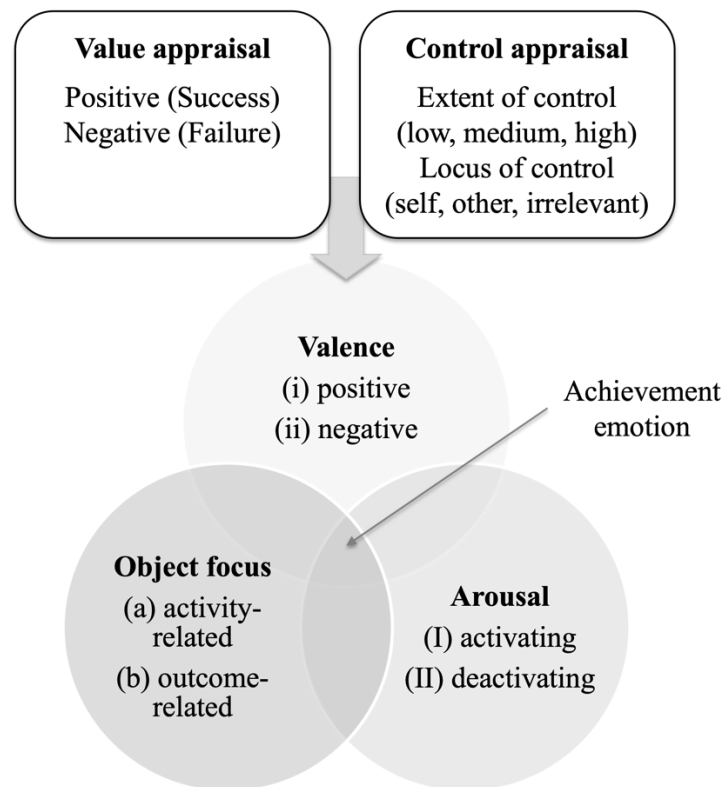
### 1.3.3 Control-Value Theory

Positive emotions towards doing research despite its problems has already been implied by the quote in the introduction (see section 1.). Furthermore, emotions are a necessary prerequisite for scientific progress (Fischer et al., 2014). However, emotional well-being of researchers in academia is questionable owing to competitive and stressful working conditions as well as insecure career paths. This difficulty has been intensified during the COVID-19 pandemic (Tran et al., 2021). To capture the emotional status of researchers in academia efficiently, theoretical

assumptions on achievement emotions in the *Control-Value Theory (CVT)* seem to be a promising approach. Conducting research, as a vocational context, is a highly selective and competitive achievement situation (see section 1.2) similar to achievement situations defined by CVT (Kwiek & Antonowicz, 2015; Pekrun, 2019).

CVT defines achievement emotions as emotions arising in achievement situations. Achievement situations are characterized through competitiveness and both possibilities of failure or success. Achievement implies both activities and outcomes including past and future outcomes. In general, achievement emotions contain various processes: affective, cognitive, motivational, expressive, and peripheral physiological processes (Pekrun, 2006). For example, joy implies that individuals feel happy and are easygoing (affect), think enthusiastic about the activity (cognition), are intrinsic motivated (motivation), show joyful facial expression (expression), and peripheral physiological activation occur (physiology) (based on Pekrun, 2006).

CVT states that individuals appraise the value of a specific activity or outcome. Furthermore, they appraise their perceived control if they are able to successfully complete the activity or achieve the outcome. Value appraisals distinguish between success as positive appraisal and failure as negative appraisal. Control appraisals are differentiated in the extent of control (high, medium, low) and the locus of control (self, other, irrelevant). Value and control appraisals predict arising achievement emotions. These emotions are further differentiated by their valence (positive vs. negative emotions), their object focus (activity-related and outcome-related emotions including retrospective as well as prospective outcome emotions), and by the related type of arousal (activating vs. deactivating) (Pekrun, 2006, 2019; Pekrun et al., 2023). Figure 5 presents an overview of key features of achievement emotions and their arising process.



**Figure 5. Process of arising achievement emotions and their key features (based on Pekrun, 2006, 2019; Pekrun et al., 2023).** Value and control appraisals predict arising achievement emotions which are differentiated on the basis of their object focus, valence, and arousal.

Within this compass-like model, there are prospective outcome emotions including anticipatory joy, hope, hopelessness, anticipatory relief, assurance, and anxiety. Retrospective outcome emotions include joy, pride, gratitude, sadness, disappointment, shame, and anger. Furthermore, the five activity-related emotions of enjoyment, anger, frustration, boredom, and relaxation are defined (Pekrun, 2006, 2019; Pekrun et al., 2023). In this thesis, the activity-related achievement emotions of enjoyment and frustration related to the specific activity of research are focused which represent both positive and negative achievement emotions.

Previous research investigates validity of achievement emotions within CVT in various learning contexts. There is evidence for CVT in school settings (Peixoto et al., 2017; Pekrun et al., 2002; Pekrun et al., 2017) as well as in higher education settings of university students (Pekrun et al., 2011; Pekrun & Stephens, 2010). However, achievement situations in higher education are not limited to experiences of university students. Conducting research is an achievement situation as well—researchers want to investigate and learn new aspects of knowledge as students in school or university learn individually new aspects of already known knowledge. Therefore, CVT can be adapted as framework for investigating emotions during research as achievement situation. Furthermore, there is evidence for the relevance of emotional

experiences in vocational contexts. Previous research found out that positions within an organization affect emotional experiences and expressions (Fitness, 2000; Saavedra & Kwun, 2000; Sloan, 2004; Tiedens et al., 2000). In sum, achievement emotions within CVT can be assumed to capture emotional experiences in academia quite well because working as a scientist is a unique mixture of a learning and vocational context shaped by high levels of competition and pressure to perform.

For embedding achievement emotions into the career decision-frame of the eRCCF (see figure 1), it can be assumed that achievement emotions are further relevant individual-level antecedents because emotions affect individual preferences relevant for career decisions: emotions are relevant in explaining career aspirations, drop-out intentions, and career decisions, for example, like the decision to quit an employment in vocational contexts (Basarkod et al., 2023; Fisher & Ashkanasy, 2000; Kidd, 1998; Pekrun et al., 2023; Pirsoul et al., 2019; Robinson et al., 2020; Weiss & Cropanzano, 1996; Young et al., 1997). Furthermore, achievement emotions influence academic achievement, behavior, motivation, and resulting well-being of individuals (Forsblom et al., 2021; Løvoll et al., 2017; Peixoto et al., 2017; Shao et al., 2020; Pekrun, 2006; Pekrun et al., 2023). Beyond effects of achievement emotions, there are several predictors of emotions. In addition to value and control appraisals predicting achievement emotions (Forsblom et al., 2021; Peixoto et al., 2017; Shao et al., 2020), showing emotions is mostly linked to interactions with social contexts (Pekrun, 2006). Previous research had already provided evidence that experiences within the social environment (gauged as basic needs) are crucial predictors of achievement emotions (Flunger et al., 2013; Pekrun, 2006). Results of previous research on CVT emphasized the relevance of integrating a broad range of emotions including both positive and negative emotions instead of investigating only anxiety (e.g., Pekrun et al., 2002, 2011). Finally, investigating researchers' emotional experiences as achievement emotions within CVT including positive and negative emotions seems to be promising to contribute to the eRCCF in explaining career decisions.

## 2. Aims

Even though there have already been efforts for improving academic working conditions and academic research career prospects (see section 1.2), an academic research career is still insecure and difficult to plan owing to competitiveness when many well-trained researchers apply for a limited number of permanent positions (BuWiN, 2021; Höhle & Teichler, 2016). Simultaneously, attractive positions outside academia—especially in the life sciences—intensify competition between academia and the labor market outside academia (Finkelstein et al., 2013; Holden, 2001). However, academia desires to win and keep the most talented researchers in academia in order to remain a sufficient pool of adequately trained applicants for permanent positions in academia (GSHC, 2023; Mantai & Marrone, 2023; Krempkow, 2017). Therefore, the question arises, what keeps life science researchers in academia despite obstacles in academia and attractive conditions outside academia. Though this dissertation was to investigate academic research careers considering both individual and institutional factors at different career stages in life science research careers in Germany. For embedding the results in up-to-date research and for discussing the findings of this thesis, the conceptual framework RCCF (Cañibano et al., 2019) is refined to the eRCCF. The original RCCF states that researchers adjust their individual preferences and institutional conditions to make a career decision in academia (Cañibano et al., 2019). However, it falls short in explaining origins of such institutional conditions and individual preferences although these factors are determined by preceding antecedents (e.g., Ortlieb & Weiss, 2018). Therefore, the refined eRCCF includes both institutional conditions and their structural antecedents as well as individual preferences and their individual-level antecedents (see section 1.). To gauge researchers' experiences in the academic environment as individual-level antecedents, assumptions of SDT, professional identity, and CVT are incorporated in the eRCCF on the basis of theoretical assumptions and previous empirical evidence. Assumptions of SDT help explaining complex social interactions in academia during research (see section 1.3.1): within SDT, the basic need for social relatedness provide a theoretical construct for explaining researchers' networks and collaboration with other researchers (like in upcoming research projects, joint publication of research, and expert discussions at conferences). The basic need for autonomy fits conducting independent research in order to extend a research profile (like raising external funds on individually selected research projects, autonomous writing of scientific articles, and designing seminars or lectures to teach). The basic need of competence is an opportunity to capture achievement-related experiences of researchers (like getting feedback of other relevant

scientists in peer-review processes, at conferences, and in project-meetings) (Deci & Ryan, 2012b). Furthermore, scholarly identity, as a facet of professional identity which is relevant in academia, develops throughout the academic career. Identification with a profession is a central antecedent of career decisions as shown by previous research (Brownell & Tanner, 2012; Lally & Kerr, 2005; Pyhältö, Nummenmaa et al., 2012; Skorikov & Vondracek, 1998). Therefore, scholarly identity as a further individual-level antecedent can be integrated in the eRCCF (see section 1.3.2). Lastly, CVT—describing achievement emotions (Pekrun, 2006)—is a framework to capture emotions in highly competitive academia because conducting research is a prototype of achievement situations (see section 1.3.3). Since recommendations of policy are assumed to cause changes in conditions of academia (see section 1.2), these recommendations are integrated in the eRCCF as structural antecedents of institutional conditions. With discussing the results owing to the eRCCF, findings of this dissertation are embedded both within higher education research on academic research careers as well as within psychological research on describing individuals' experiences.

To approximate to the complex process of decision-making in academic research careers, this dissertation was aimed at investigating individual and institutional factors influencing academic research careers. Therefore, the following three aims were pursued in this dissertation (see figure 6): in a first step, doctoral education was examined more in-depth with aim one and two. Doctoral studies are the starting point of academic research careers where junior researchers conduct their first independent research (see section 1.1.1). This phase has an impact on further career trajectories (Jaksztat et al., 2017).

- 1) Several recommendations of policy and previous research emphasized weaknesses in doctoral education (HRK, 2012; Nerad, 2008; Schneijderberg, 2018). Implementation of doctoral programs and advancement of doctoral programs should address numerous points of criticism. However, it is still unknown to what extent current recommendations of policy on improving doctoral education are implemented in doctoral programs. Thus, this dissertation was to examine the extent to which recommendations of policy and empirical results of previous research were implemented in life science doctoral programs. Therefore, stated structures in those doctoral programs were evaluated on the basis of previous published recommendations of policy and research on improving doctoral education.

Publication I addressed the first aim.



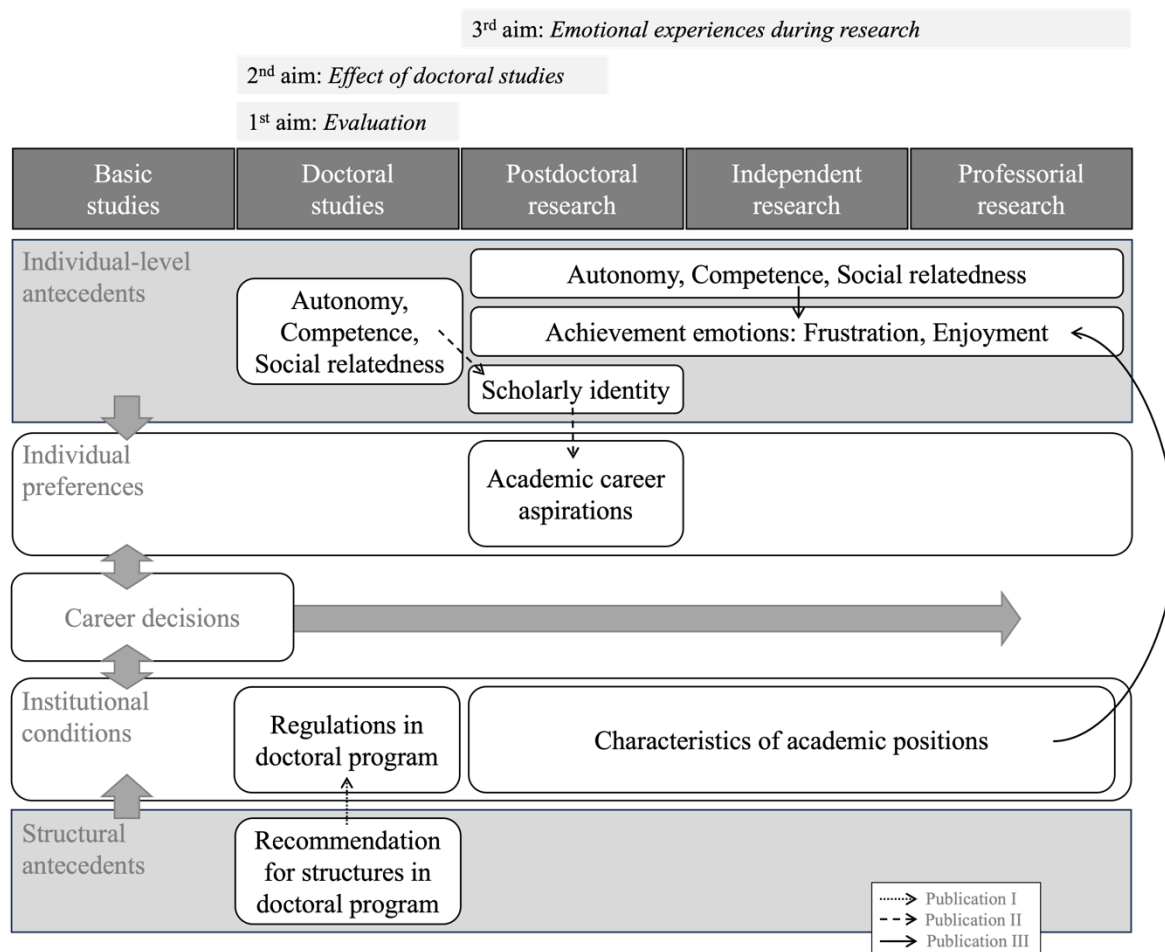
- 2) Developing an identity as a scholar is a central aim of doctoral studies (Pyhältö, Nummenmaa et al., 2012). Furthermore, academia relies on a sufficient pool of suitable candidates who aspire an academic career path because successful selection of permanent academic staff (such as professors) depends on the opportunity to select the best researchers out of this pool of candidates (Krempkow, 2017). Therefore, the question arises what experiences of scientists contribute to their aspiration to continue their research careers. Especially, long-term effects of experiences during doctoral studies on later identity in the academic context and career aspirations in the life sciences are unknown. Therefore, this dissertation was aimed at investigating what experiences during doctoral studies remain a lasting imprint on academic career aspirations after doctoral graduation. Theoretical assumptions and previous research emphasize the relevance of basic needs support for developing a scholarly identity and academic career aspirations (see sections 1.3.1 and 1.3.2). In a longitudinal study, the association of a basic need supportive environment during doctoral studies in the life sciences with scholarly identity as well as the aspiration to pursue an academic career path one year later were investigated.

The second aim was addressed in Publication II.

Beyond analyses of the first academic research career stage of doctoral studies, further career stages after doctoral graduation from postdoctoral research assistant to PIs (see sections 1.1.2–1.1.4) were investigated as recommended (ESF, 2012).

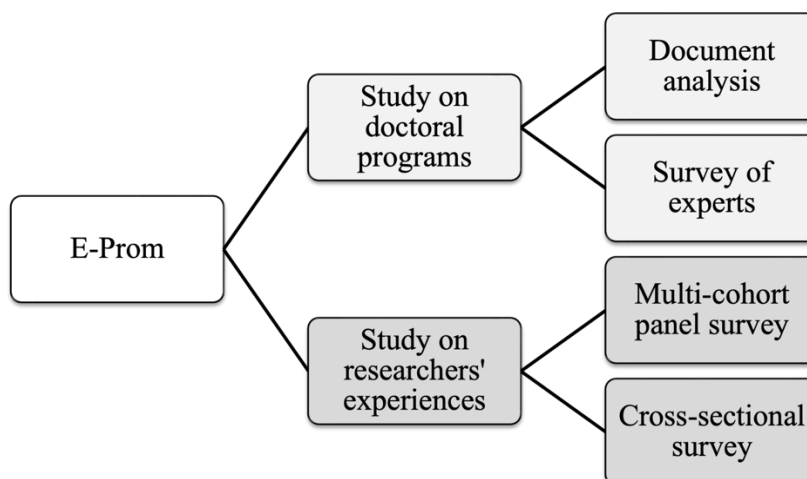
- 3) Owing to various challenges in academic research, emotions are closely linked to research and academic work (Fischer et al., 2014; Tran et al., 2021). However, predictors of emotional experiences during research in the life sciences as individual-level antecedent of academic progress and career aspirations are not yet investigated. Furthermore, research on patterns of emotional experiences in academic positions with and without leading responsibility is lacking. Therefore, this doctoral thesis was aimed at investigating what experiences within the social environment of academia frame researchers' emotional experiences in different positions. Considering assumptions of CVT and SDT as well as empirical evidence on the link between basic needs and achievement emotions (Flunger et al., 2013), the associations of a basic need supportive environment and the researchers' academic position with achievement emotions during research were analyzed in this doctoral thesis.

Publication III analyzed aim three.



**Figure 6. Overview of the aims of this doctoral thesis.** Both individual preferences and institutional conditions as well as their antecedents were assumed to shape progress of academic research careers in the life sciences throughout the stages of a research career (based on Abele, 2002; Berweger, 2008; Cañibano et al., 2019; EC, 2011; ESF, 2012). Individual-level antecedents influencing individual preferences and, thus, career decisions were investigated on the basis of SDT, scholarly identity, and CVT in Publication II and III. Institutional conditions of doctoral program' regulations were adjusted with structural antecedents (Publication I). For the following discussion of the results, the eRCCF had been applied to the overview of the aims.

The three aims were investigated in samples of German life scientists collected within the BMBF-funded *E-Prom*-project on *Influencing factors on academic career paths of graduated life scientists* (Epstein et al., 2020; Fischer & Epstein, 2017; Meuleners et al., 2020; von Kotzebue et al., 2017). Aim one was addressed in a study on doctoral programs while the second and third aim were addressed in a study on researchers' experiences within the *E-Prom*-project (see figure 7). In a mixed methods approach (Gläser-Zikunda et al., 2012), both quantitative (survey data) and qualitative data (document analysis, survey of experts) were collected.



**Figure 7. Overview of data collection.** Within the BMBF-funded project *E-Prom* on *Influencing factors on academic career paths of graduated life scientists*, qualitative and quantitative data were collected. In the study on doctoral programs, regulations of doctoral programs were investigated in both a document analysis and in surveys of program experts. In the study on researchers' experiences, doctoral graduates answered to online-questionnaires in a multi-cohort panel study and a cross-sectional survey.

In the study on doctoral programs, conditions of doctoral education in doctoral programs were examined in more detail. Therefore, online documents collected between 2014 and 2018 about doctoral programs were analyzed in which life scientists of the multi-cohort panel study participated. In a document analysis, regulations of doctoral programs were examined using the structure of qualitative content analysis (Mayring, 2015). Additionally, some experts of the respective doctoral programs answered to an online-survey in 2018-2019. Aim one was addressed in the study on doctoral programs ( $N = 82$ ).

In the study on researchers' experiences, a multi-cohort panel study with graduated life scientists of 13 representative German universities was conducted beginning in 2014 until 2018. For representing German academia, a cross section of German universities was invited including large and small universities from different German states as well as with different focuses (technical and non-technical universities). In the multi-cohort panel study, three cohorts were surveyed about influencing factors on their academic careers, for the first time directly after their doctoral graduation and afterwards every year until 2018. Participants of the first cohort finished their doctoral studies in 2013, participants of the second cohort in 2014, and, lastly, participants of the third cohort in 2015 (first datasets can be found at: Fischer et al., 2017a, 2017b). Furthermore, an additional sample of graduated life scientists, who were employed in academia holding different academic positions (from postdoctoral positions to professorship positions) were investigated in a cross-sectional study in 2018. To investigate aim

two a subsample of the multi-cohort panel study was used ( $N = 180$ ). Aim three was analyzed in a subsample of the cross-sectional survey ( $N = 250$ ).

### 3. Results

### 3.1 Publication I

Julia S. Meuleners, William J. Boone, Martin R. Fischer, Birgit J. Neuhaus, and Julia Eberle

Evaluation of structured doctoral training programs in German life sciences: how much do such programs address hurdles faced by doctoral candidates?

published in  
Frontiers in Education  
Section Higher Education

Meuleners, J. S., Boone, W. J., Fischer, M. R., Neuhaus, B. J., & Eberle, J. (2023). Evaluation of structured doctoral training programs in German life sciences: how much do such programs address hurdles faced by doctoral candidates? *Frontiers in Education*, 8(930283). <https://doi.org/10.3389/feduc.2023.930283>

### 3.2 Publication II

Julia S. Meuleners, Birgit J. Neuhaus, and Julia Eberle

The role of scholarly identity and basic needs support during doctoral studies on career aspirations of early career scientists

published in  
Studies in Higher Education

Meuleners, J. S., Neuhaus, B. J., & Eberle, J. (2023). The role of scholarly identity and basic needs support during doctoral studies on career aspirations of early career scientists. *Studies in Higher Education*. <https://doi.org/10.1080/03075079.2023.2217726>

### 3.3 Publication III

Julia S. Meuleners, Birgit J. Neuhaus, and Julia Eberle

Basic needs support and achievement emotions in daily research of life scientists considering  
academic positions

published in  
Frontiers in Education  
Section Higher Education

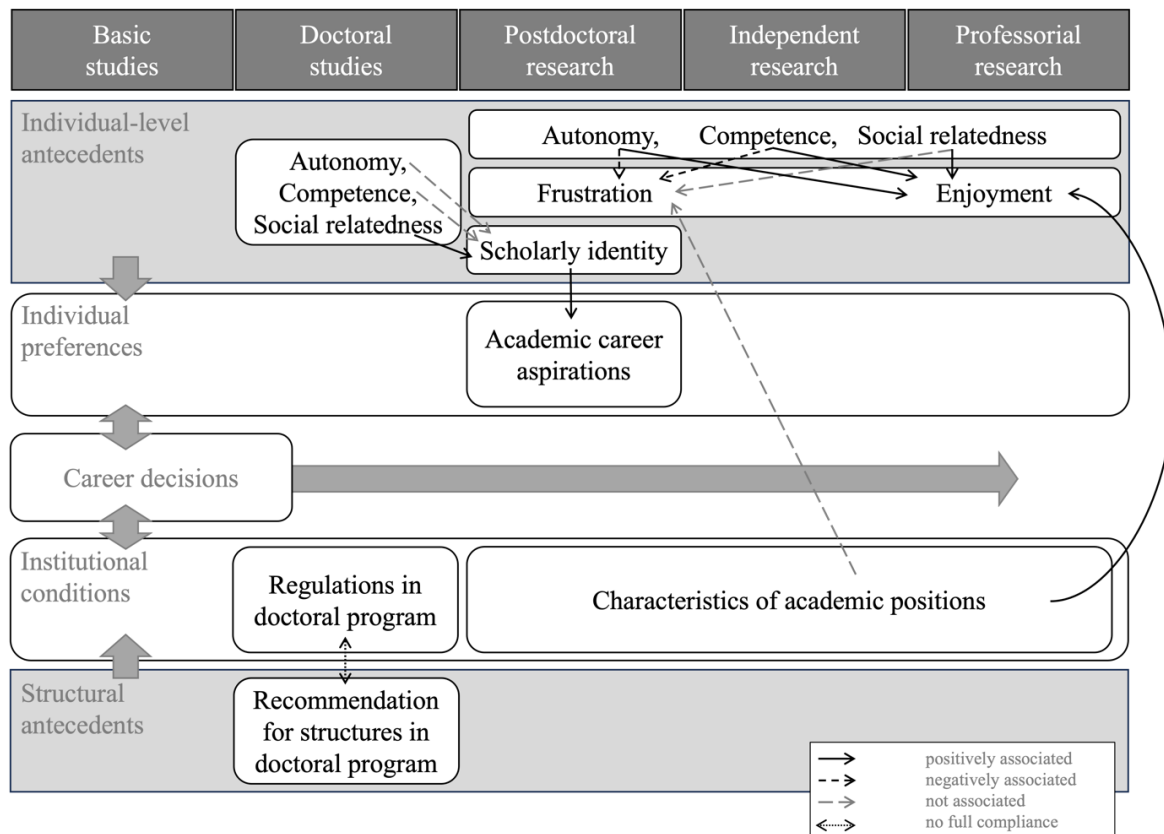
Meuleners, J. S., Neuhaus, B. J., & Eberle, J. (2022). Basic needs support and achievement emotions in daily research of life scientists considering academic positions. *Frontiers in Education*, 7(868752). <https://doi.org/10.3389/feduc.2022.868752>



## 4. Discussion

The findings of this doctoral thesis on the three aims (see section 2.) are discussed chronologically along the prototypical stages of an academic research career (see section 1.1.1-1.1.4). First, findings on life science doctoral studies as the first stage of an academic research career are addressed (see section 4.1). Therefore, results of the first and second Publication are summarized and linked to current theoretical and empirical literature. Considering recommendations of policy and previous research results, descriptive results on life science doctoral programs (Publication I) are evaluated (see section 4.1.1). Furthermore, the impact of researchers' experiences during doctoral studies as described in Publication II on later desires to pursue an academic career path or not is reviewed (see section 4.1.2). Second, findings on later career stages after doctoral graduation (postdoctoral, independent, and professorial research) are summarized and linked to current literature (see section 4.2). In the third part of the discussion, limitations of this thesis are gathered (see section 4.3). Results and limitations of this thesis lead to further research on academic research careers especially in the life sciences as described in the fourth part of the discussion (see section 4.4). Finally, theoretical implications for complementing the eRCCF (see section 4.5.1) as well as practical implications for doctoral education and further academic career stages are derived (see section 4.5.2).

This dissertation was aimed at investigating institutional and individual factors to explain academic career decisions (see figure 6). Figure 8 presents an overview of the main findings of this doctoral thesis embedded within the eRCCF for discussing the results in the following sections. It shows the investigated individual-level antecedents (support of autonomy, competence, social relatedness to the scientific community, scholarly identity, and achievement emotions), related individual preferences (academic career aspirations) as well as institutional characteristics (doctoral program' regulations, characteristics of academic positions with and without leading responsibility) and their antecedents (recommendations of policy) at the different career stages (from doctoral studies upon professorial research).



**Figure 8. Overview of the main findings of this doctoral thesis.** The eRCCF has been applied to the four career stages of academic research careers and the main findings have been assigned. Structural antecedents (recommendations of policy and assumptions of current research on improving doctoral programs) were not fully in alignment with institutional conditions (regulations in doctoral programs) during doctoral studies. Furthermore, individual-level antecedents of individual preferences (academic career aspirations) were linked together: basic needs (support for autonomy and competence as well as social related-ness to the scientific community) were associated with scholarly identity and achievement emotions. Institutional conditions (characteristics of academic positions) were partly associated with individual-level antecedents (achievement emotions).

## 4.1 Doctoral studies

In a first step, characteristics of doctoral education as the obligatory starting point in academic research careers were analyzed from different perspectives. The investigation on the doctorate was divided into two analyses: first, an evaluation of recommended improvements for doctoral education in life science doctoral programs was discussed to investigate structural antecedents and institutional conditions during the first career stage more in-depth (see section 4.1.1). Second, longitudinal associations of individual-level antecedents and individual preferences were discussed on the basis of the analysis of researchers' experiences, later identification as a scholar, and the aspiration to pursue an academic career (see section 4.1.2). This two-part analysis of doctoral studies is an attempt to explore the complexity of career decisions, their underlying experiences and conditions, and related antecedents during the doctorate. In order to contribute to the leading research question what keeps researchers in academia, the results on this first career stage are discussed owing to the eRCCF.

### 4.1.1 Evaluating structural antecedents and institutional conditions during doctoral studies

First, this dissertation was to investigate the current implementation of recommendations of policy as structural antecedents in life science doctoral programs to explore institutional conditions of doctoral education (see figure 6).

Publication I showed that many doctoral programs provided opportunities for interdisciplinary cooperation, whereas there were still some doctoral programs only accepting doctoral candidates of a single research field (for example, pure medical programs). Regarding the international orientation of doctoral programs, it is conspicuous that most doctoral programs still did not offer their participants to earn the international PhD-degree, to attend courses in English, and to conduct research in international cooperation with universities from abroad. In Germany, however, higher education policy has been recommending increasing internationalization of research for almost 30 years. Already 1992, the GSHC suggested cooperation between universities, stays abroad for students and academic staff, and stays of international students and academic staff from abroad in Germany (GSHC, 1992). In the offered courses doctoral candidates could train skills related to central research activities (networking, collaborating, research management, conducting research, and publishing research) (Kyvik, 2013). However, many doctoral programs were lacking course offers in further research-related skills (teaching research, publish open access, public outreach of research results, funding research (Boyer, 1990; Creaser, 2010)). Particularly, doctoral candidates were trained less in teaching skills although teaching is a crucial factor for several reasons: internationally, teaching

skills are increasingly required during formal application processes at later career stages (when applying for positions to conduct independent and professorial research) (Mantai & Marrone, 2023). When researchers teach current research, they have to expose their research to questions and criticism of the students—strengthening criticism and self-criticism of research results (GSHC, 2011b). Furthermore, support in personal and career development was rarely offered in the investigated doctoral programs. Considering doctoral supervision, there were still doctoral candidates supervised by only one supervisor in some doctoral programs. Additionally, only a few doctoral programs structured supervision using supervision agreements, stating the frequency of meetings between supervisors and supervisees, and through further support of TACs and mentors. However, GSHC currently demands for diversity in supervision: supervisors should guide doctoral candidates through doctoral studies counselling in research- and research field-related issues while an additional TAC socially supervise the candidates (GSHC, 2023). Many regulations of doctoral programs on examination still intended supervisors to evaluate and grade the supervised doctoral thesis. Although there were several policy initiatives and efforts for improving doctoral education in doctoral programs through increased structuring (Bao et al., 2018; GSHC, 2002; HRK, 2012; Maloshonok & Terentev, 2019; Nerad & Heggelund, 2008; Nerad, 2008; Schneijderberg, 2018), results of Publication I emphasized a further need for improvement of doctoral education in German life science doctoral programs.

Prior research also investigated doctoral programs in Germany. Martius and colleagues (2014) as well as Lachmann and colleagues (2020) examined results on preliminary datasets of the *E-Prom*-project. In addition to previous investigations (Lachmann et al., 2020; Martius et al., 2014), more recent data and further aspects of doctoral education were investigated in Publication I. While previous studies examined course offers as formal and informal learning formats (Lachmann et al., 2020; Martius et al., 2014), the focus of the analysis in Publication I was on the content and scope of these offers (distinguishing different forms of research-related competences and key competences relevant in both academic and non-academic vocations). Previous results on regulations of doctoral programs and self-reports of doctoral candidates showed that course offers in general were moderately accepted by the doctoral candidates (Lachmann et al., 2020; Martius et al., 2014). Nevertheless, only if the structural framework of doctoral education provides opportunities for doctoral candidates to participate such courses, more doctoral candidates can accept these offers. However, results on missing comprehensive course offers on research-related skills (such as teaching research, public outreach) and on key competences (personal and career development) emphasized that such offered learning opportunities should be expanded in more doctoral programs. Comparing results of previous

analyses on supervision (Lachmann et al., 2020) with results of Publication I, it is conspicuous that supervision agreements are still not used comprehensively in life science doctoral programs.

Beyond the results of the *E-Prom*-project, Kwan (2010) conducted a document analysis on doctoral programs as well. Analysis of supporting offers in doctoral programs in Hong Kong showed that offers on research publishing were not sufficiently provided in these programs (Kwan, 2010). In addition to findings of Kwan (2010) on a single research-related skill (publishing research), findings of Publication I provides a broader insight in the diversity of courses offered in doctoral programs considering the variety of tasks in researchers' academic careers later on (see section 1.2). Additionally, Publication I further details findings of Kwan (2010) on publishing research when life science doctoral programs mainly lack support in publishing open access as a subcategory of publishing research (Creaser, 2010).

Furthermore, the BMBF fund regularly reports on various aspects of working and conducting research in academia for junior researchers (see section 1.2.2). Doctoral education and doctoral programs in particular are examined among other topics (e.g., BuWiN, 2017, 2021). The comparison of previous results and findings of Publication I reveals some deviations regarding (1) international orientation, (2) supervision, and (3) examination: (1) in general, doctoral studies in Germany are mostly conducted without national or international cooperation with other universities, non-academic research institutes or other institutions (BuWiN, 2021). Rare cooperation with universities from abroad (BuWiN, 2021) matches the finding on lacking international orientation in Publication I. (2) Supervision agreements provide structure for doctoral studies in many cases in Germany. In doctoral programs, the number of doctoral candidates who agree on such an arrangement is higher than in the traditional master-apprentice-model (BuWiN, 2021). These subject-unrelated results from the national report BuWiN do not tally with results on life science doctoral programs, where only a few doctoral programs stated to use supervision agreements. Therefore, results of Publication I seem to be field-specific. However, doctoral programs may not explicitly state in their regulations that they use supervision agreements because such agreements are provided anyway at life science faculties. Further research should investigate underlying structures of faculty in more detail. Most doctoral candidates enrolled in doctoral programs meet their supervisors several times during a semester (BuWiN, 2021). In contrast, the frequency of meetings between supervisors and supervisees was mostly not defined in life science doctoral programs. However, it should be considered that results of Publication I were on the basis of regulations of doctoral programs while the statement of the national report referred to data of NACAPS (BuWiN, 2021;

NACAPS Website). In the NACAPS, doctoral candidates reported their experiences in self-reports. Therefore, the results of the national report and of this doctoral study do not have to be contradictory because doctoral candidates may regularly meet their supervisors albeit regularly meetings are not required in the regulations of the doctoral programs. (3) It is conspicuous that the national report did not investigate examination regulations in more detail. The previous approach that supervisors examine doctoral studies bears a potential conflict of interest when supervisors grade a thesis on the basis of shared publications of supervisors and supervisees (publication-based thesis) or their own supervision (monograph) (see section 1.1.1). Supervisors may examine doctoral studies not as objective as supposed when they rate their own work (GSHC, 2011a, 2023). Findings of the document analysis in Publication I emphasized that the described approach is still common in life science doctoral programs. However, results of the survey of experts provided insight in an alternative approach of examination, when supervisors describe progress in doctoral studies and assess the performance of the respective doctoral candidate while external examiners evaluate and rate doctoral studies. External examiners can include supervisors' report at their own discretion. This approach exceeds a current statement of the GSHC in 2023: an independent report of a second examiner should be included in an examination process while publications with the second examiner should be avoided. Again, an external examiner is desired (GSHC, 2023). However, in the GSHC's recommendation, the supervisor can still examine the thesis.

Regarding the findings of Publication I on rare courses on teaching as well as offers for career and personal development, it should be mentioned that some universities offer such training sessions independently from academic positions and programs: for example, the LMU in Munich provides offers on teaching competence in the project *PROFiL* (Professionell in der Lehre [Professional teaching]) (*PROFiL Website*) or on handling stress as well as on consulting skills in the *CfLPM* (*CfLPM Website*). Thus, doctoral candidates could improve such competences outside of doctoral programs. Nevertheless, doctoral programs also should include such offers in their agenda for several reasons: first, offers on teaching and personal development in doctoral programs could compensate inequality of opportunities at smaller universities which could not provide such offers like the LMU. Second, offers of the university are mostly on a general level and not subject-specific. However, teaching in life sciences includes knowledge about how to teach some subject-specific skills (such as skills in experimenting or compiling charts) in the sense of subject education (such as biology education, chemistry education, medical education). Consequently, doctoral programs should provide training on subject-specific teaching in addition to subject-unrelated training offers of the

university. Third, career paths in the life sciences are very diverse (life scientists may work in hospital, academic research, non-academic research, laboratories, NGOs, government agencies, and many more), so offerings on career development need to be designed with this subject-related particularities in mind. In summary, offers on teaching as well as career and personal development should be increasingly provided by doctoral programs themselves with a subject-specific approach—especially in the life sciences.

Particularly, in medicine, doctoral programs are discussed because doctoral programs were introduced to address criticism on doctoral theses' quality (GSHC, 2011a, 2023). For example, an association of German universities mapped online where doctoral programs in medicine have already been offered (Landkarte Hochschulmedizin Website). Extending this overview, results of Publication I provided insight in the design of life science doctoral programs including medical programs (interdisciplinary cooperation, international orientation, training offers, supervision, and examination).

Different program types (from graduate schools without subject-focus to subject-specific programs on a single topic) and inconsistently definition of doctoral programs result in hampered research on doctoral programs (for example, capturing the number of doctoral candidates enrolled in doctoral programs is methodically problematic (BuWiN, 2021; GSHC, 2023)). These difficulties underpin the relevance of empirical analyses on specific doctoral programs for improving research results on doctoral programs, as done in Publication I.

Previous research had already hinted that doctoral candidates' experiences during doctoral studies are highly relevant for career decisions and further career paths (Jaksztat et al., 2017; Schnoes et al., 2018). Since experiences during the initial phase of academic research careers serve as a basis for career decisions and further progress of an academic research career, investigating institutional conditions shaping these experiences and their structural antecedents (as done in Publication I) is an important research issue to understand career decisions. Thus, results of Publication I contribute to the eRCCF showing that structural antecedents are related to institutional conditions although they were not fully in alignment. Additionally, individual preferences affected by individual-level antecedents are another relevant factor in career decisions as suggested in the eRCCF (see figure 1). Therefore, findings of Publication II on longitudinal associations of researchers' experiences during doctoral studies as individual-level antecedents with later individual preferences are discussed in the following section.

#### 4.1.2 Doctoral candidates' individual-level antecedents and their long-term effect

Second, this dissertation was aimed at further investigating career decisions focusing on individual factors. Particularly, academic career aspirations as individual preferences and their individual-level antecedents of basic needs and scholarly identity were examined (see figure 6).

For capturing relevant groups in academia, Publication II focused on social relatedness to scientific communities as basic need (Kienle & Wessner, 2005; Deci & Ryan, 2002; 2012b). Social relatedness to scientific communities during doctoral studies was positively associated with scholarly identity and academic career aspirations of graduated life scientists one year later. Doctoral graduates in the life sciences, who felt highly related to scientific communities were more likely to identify themselves as scholars and, thus, to stay on track in an academic career path. Thus, results of Publication II hinted that individual-level antecedents had a long-term effect on individual preferences supporting the assumption of the eRCCF that individual-level antecedents are crucial factors in explaining academic career decisions (see figure 8). Publication II had provided first indications that experiences during the doctorate may be worthwhile for explaining resilience during need-thwarting experiences in postdoctoral research periods. Positive, need-supporting experiences during doctoral studies served as a basis for coping with negative experiences and for strengthening positive experiences later on as described in Publication II. Surprisingly, support of the remaining two basic needs of autonomy and competence seemed to be less relevant for explaining career aspirations in academia (Publication II). Support of autonomy and competence were neither directly nor indirectly via the mediator scholarly identity related to academic career aspirations. The results of Publication II add to findings of previous research: The finding that social relatedness is highly relevant in explaining career aspirations details previous research results on the relevance of doctoral candidates' experiences during doctoral studies for further career progress (Jaksztat et al., 2017). Beyond structural aspects shaping further career paths (like the final grade of the dissertation or the number of published research articles during doctoral studies (Briedis et al., 2014; BuWiN, 2021)), individual aspects like relationships to other scientists are relevant for pursuing an academic research career (Berweger, 2008; Briedis et al., 2014). The results of Publication II with an SDT-approach add insights in gauging such networks with other scientists as the basic need of social relatedness. Beyond evidence for the effect of supportive environments during doctoral studies on simultaneous drop-out intentions (Cornér et al., 2023), the longitudinal analysis in Publication II adds initial hints on sustainable relationships of these variables across the boundaries of two career stages for social relatedness. In summary, relatedness to scientific communities was associated with central aims of doctoral



studies (scholarly identity development) as well as with the willingness for further career progress. These results emphasize the relevance of support for networking that can be provided in the formal as well as in the hidden curriculum (Elliot et al., 2020). However, the relevance of the social environment providing competence- and autonomy-supportive structures which explain career decisions in academia should be further investigated.

Previous investigations of the *E-Prom* team have already indicated the complexity of influencing factors on the aspiration to pursue an academic career. In cross-sectional analyses, several factors influencing career aspirations of life scientists were analyzed (such as self-efficacy, gender, achievements during doctoral studies, parenthood, integration in academic institutions, social capital, among others) (Epstein, 2016; Epstein & Elhalaby, 2023; Epstein & Fischer, 2017; Epstein et al., 2018; Epstein & Lachmann, 2018; Epstein et al., resubmitted; Mozhova, 2018). Results of Publication II on missing associations of competence support with career aspirations contradict previous findings: for biologists, competence support was positively associated with career aspirations mediated by published articles in a cross-sectional analysis (Mozhova, 2018). Owing to these differences, it can be assumed that effects of supporting the need for competence during doctoral studies were mostly temporary. Long-term effects of such support on later academic careers seem to be difficult to provide although there had already been evidence for the relationship of basic needs, identity, and drop-out in cross-sectional as well as in previous longitudinal studies (Faye & Sharpe, 2008; Luyxck et al., 2009; Van der Kaap-Deeder et al., 2020). Missing associations of supporting autonomy with career aspirations both in cross-sectional analyses (Mozhova, 2018) and in longitudinal analyses (Publication II) may imply that supporting autonomy seems to be less necessary for increasing the likelihood of the aspiration to stay in academia. However, another explanation for the missing relevance of autonomy could be that the ad hoc scale insufficiently represented complexity of autonomy support in academic environments (see section 4.4). Furthermore, analyses of the first survey in the *E-Prom* panel study (on life scientists who have just completed their doctoral studies) suggested relevance of a scientific community for career aspirations at the same time (Epstein & Lachmann, 2018; Mozhova, 2018). Benefits from integration in a scientific community were less favorable for women than for men (Epstein & Lachmann, 2018). Life scientists were more likely to stay in academia when they were well-supported through their social environment. This association was mediated by scientific interest in a cross-sectional investigation of Mozhova (2018). Epstein and Elhalaby (2023) figured out that integration in a scientific community and academic career aspiration were positively associated for life science postdocs, too. They examined the last survey of the panel study in addition to

the cross-sectional survey within the *E-Prom* dataset (study on researchers' experiences). Additionally, satisfying relationships to researchers of the local research group (such as the professor) were also relevant in explaining postdocs' aspirations to stay in academia (Epstein & Elhalaby, 2023). Beyond research in the *E-Prom*-project, further studies provided evidence for the relevance of communities in identity development (Cai et al., 2019). Results of Publication II added to this previous literature: besides local working groups (Epstein & Elhalaby, 2023), relatedness to scientific communities as a crucial social group in academia was relevant in explaining career aspirations in Publication II. This result supports previous findings of Epstein and Lachmann (2018) as well as Mozhova (2018). Furthermore, results of Publication II showing the association of social relatedness and scholarly identity as a facet of professional identity supported previous studies (Cai et al., 2019). Lastly, findings of longitudinal analysis in Publication II extended insights in the relevance of social relatedness to the scientific community for academic career aspirations on the long run beyond cross-sectional analyses (Epstein & Lachmann, 2018; Mozhova, 2018). Experiences during doctoral studies were not solely related to career aspirations at the same time, but to career aspirations one year later. Evidence for sustainable effects of individual-level antecedents during doctoral studies emphasizes urgency of further improving doctoral education. Unlike findings of Epstein and Lachmann (2018) on gender-related differences in benefiting from relatedness to scientific communities, Publication II showed that associations of integration in a scientific community with career aspirations mediated by scholarly identity were independently from gender.

In Publication II, previous assumptions that basic needs influence the aspiration to stay or to leave an academic institution (Vallerand et al., 1997) were transferred to the academic context after doctoral graduation. Vallerand and colleagues (1997) conducted a study on high school students' intentions to drop out of school. Low support of basic needs led to a more likely drop-out (Vallerand et al., 1997). Beyond these findings, results of this dissertation provided evidence for the relationship of basic needs and the likelihood of leaving an academic research career path. Postdocs tend to leave academia after their doctoral graduation if their social relatedness during doctoral studies was low. Consequently, the basic need of social relatedness as a predictor of drop-out intentions is highly relevant in both contexts—in early educational contexts (like high school) and in late ones (like academia after doctoral graduation).

After discussing researchers' experiences during doctoral studies as the initial phase of academic research careers, experiences of researchers after doctoral graduation are focused in the following section. Although higher education policy requests research on academic research

career stages after doctoral graduation, studies on these career stages are rare (ESF, 2012). Therefore, Publication III focused on career stages of postdoctoral, independent, and professorial research.

#### **4.2 Emotional experiences during research after doctoral graduation**

Emotions are assumed to be individual-level antecedents of individual preferences for or against an academic research career path and are therefore relevant factors in explaining academic career decisions. Previous research had already shown that emotions influence career aspirations in other contexts (Fisher & Ashkanasy, 2000; Pekrun et al., 2023; Robinson et al., 2020; Weiss & Cropanzano, 1996). To explain the arising of such emotions, this dissertation was to investigate individual-level antecedents and institutional conditions associated with emotional experiences during research in academia. Therefore, Publication III focused on a basic need-supportive environment and academic positions related to achievement emotions of researchers at different career stages after doctoral graduation. The results revealed the relevance of basic needs and characteristics of academic positions for explaining the achievement emotions of enjoyment and frustration during research: high levels of autonomy and competence support were related to low frustration when doing research. Whereas, a distinct relatedness to the scientific community was not associated with researchers' experiences of frustration at all. Also, characteristics of academic positions with (PI) and without leading responsibility (research assistant) were not relevant in specifying research-related frustration. For explaining enjoyment in research, autonomy support, competence support, and social relatedness to the scientific community were significant predictors. On the basis of missing variance and results of an analysis on the factorial structure, findings on the negative activity-related achievement emotions anger and boredom had to be excluded from analyses.

After data collection in 2018, a three-dimensional taxonomy of achievement emotions was published (Pekrun, 2019; Pekrun et al., 2023). The achievement emotions of enjoyment and frustration had been more precisely defined through the description of the related arousal (see section 1.3.3). Owing to the most up-to-date taxonomy of 2023 (Pekrun et al., 2023), enjoyment as a positive, activating emotion is conducive to conducting research, as described in publication III. However, the definition of frustration slightly changed in the taxonomy: although frustration was described as a negative, deactivating achievement emotion in Pekrun (2019), frustration is now defined as a negative, activating emotion (Pekrun et al., 2023). In contrast to the original classification as a deactivating emotion, frustration as an activating emotion is now assumed to lead to new strategies of action in parallel with anger as another

negative, activating emotion (Pekrun, 2019). These new insights lead to a slightly different discussion of practical implications derived from the results of Publication III: perceiving frustration should not prevail because negative emotions are associated with negative outcomes (such as health problems). This association had been empirically exemplified for anger (Pekrun et al., 2023). Thus, the level of frustration should be lowered but the researchers should not attempt to avoid frustration at all because it can lead to new strategies in research. Many scientific findings, especially in the life sciences, are based on failed approaches of, for example, experiments that led to an improved approach or to a better approach replacing another one (such as in the search for a cure for tuberculosis (e.g., Gradmann, 2001)). Though a certain amount of frustration is inseparable from scientific progress (e.g., BuWiN, 2021).

Staying in academia after doctoral graduation mostly implies that postdocs need to accept partially precarious working conditions (like long working hours due to several tasks of teaching, administration and patient care in medicine in addition to research) and insecure career prospects during early postdoctoral research (such as few permanent positions and many fixed-term contracts) (e.g., BuWiN, 2021; Kehm, 2006) (see section 1.2). However, these characteristics are changing when researchers achieve a permanent academic position like an appointment to a professorship position (professorial research) or a junior professorship position with a permanent position in prospect (independent research) (see section 1.1.2-1.1.4). Such positions summarized as PI (independent and professorial research positions) are mostly associated with the opportunity to conduct independent scientific research and more secure institutional positions (Höhle & Teichler, 2016). Findings of Publication III hinted that such differences in characteristics of the academic positions between research assistants and PIs seemed to be associated with slightly different emotional experiences (see figure 8): PIs experienced significant higher levels of positive achievement emotions than research assistants (enjoyment). Positions in academia were not related to differences in negative achievement emotions (frustration).

These results further extend the value of institutional conditions within the eRCCF. Results of Publication III on the relationship of institutional conditions (academic positions) and individual-level antecedents (achievement emotions) further emphasized the complexity of academic career decisions when institutional and individual factors did not only interfere with each other during the decision-making process (Cañibano et al., 2019), but were already linked beforehand (see section 4.6.1).

A survey on professors (professors are assigned to the group of PIs) indicated that pursuing an academic research career is associated with enthusiasm when doing research

(BuWiN, 2021)—as already indicated in the introducing quote (see section 1.). Results of Publication III extend these findings through providing insights in the patterns of the specific achievement emotions frustration and enjoyment. Furthermore, the survey on professors showed that researchers who had already reached the desired permanent position as a professor indicated that primarily tolerating frustration, autonomous working, and ability for networking were crucial factors in pursuing an academic research career path (BuWiN, 2021). Results of Publication III concretize these qualitative findings in a quantitative approach embedded in SDT and CVT: a social environment supporting researchers in feeling autonomous and competent as well as a good network with scientific communities promoted positive emotional patterns. However, missing association of the academic position with the experience of frustration in the findings of Publication III does not match results of the survey on professors that especially coping with frustration is a key issue in professorial research. Instead, Publication III's results has provided first indications that perceiving frustration seems to be comparably relevant at all career stages after doctoral graduation. Combining previous results on professors (BuWiN, 2021) and results of Publication III, it can be concluded that researchers' emotional status should be focused throughout different academic career stages ranging from research assistants to PIs. Therefore, academia should consider to foster academic staff in their emotion regulation, in supporting autonomous working, competence experiences, and networking with the scientific community for promoting positive emotional patterns during research.

A participant's comment on the cross-sectional survey reveals insights into the experience of frustration as a postdoc:

"I would like to comment that the stated prevailing frustration is mainly owing to the latent publication delay (when manuscripts often lie around for months...), which significantly slows down my academic progress (and thus, for example, my habilitation). Simultaneously, my academic progress is hindered by high (and increasing) numbers of administrative tasks."<sup>5</sup>

Here, the origin of perceived frustration is specified as related to publishing research as well as to managing research as central tasks in research (Kyvik, 2013). Though this quote has provided a hint for further predictors of research-related frustration which should be investigated in future research. A further participant's quote on the cross-sectional survey illustrates the complex interplay of emotionality in research and academic research careers despite institutional obstacles:

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<sup>5</sup> I translated the original German quote into English.

„I really appreciate the way my work is proceeding now. I enjoy working with the students. We are making progress in research. Unfortunately, it is precisely this job profile that is at risk of extinction. I have decided to stay on track as long as I can, even if the air is getting thin.”<sup>6</sup>

This optional comment on the survey emphasizes that researchers experience quite high levels of enjoyment although institutional conditions hamper career progress and security of employment situations. The quote supports the approach of this doctoral thesis to take a look at both aspects to capture complexity of career decisions in academia—the individual-level antecedents of individual preferences as well as the structural antecedents of institutional conditions.

Embedding the findings on basic needs, achievement emotions and academic positions of Publication III within the eRCCF, it should be noted that emotional experiences of researchers are relevant for understanding achievement, individual preferences for pursuing or quitting an academic research career as individual preferences, and lastly for career-decisions (e.g., Pekrun, 2006; Pekrun et al., 2023; Robinson et al., 2020; Weiss & Cropanzano, 1996). Findings of Publication III support assumptions of the eRCCF showing the complex interplay of individual-level antecedents (basic needs and achievement emotions) which are relevant in explaining individual preferences (career aspirations) and career decisions (Pekrun et al., 2023; Robinson et al., 2020). Furthermore, results of Publication III extend the eRCCF providing evidence for the linkage of institutional conditions and individual-level antecedents (see figure 8).

### 4.3 Limitations

There are some methodological limitations of this study that should be considered here. First, doctoral programs within the study of the *E-Prom*-project had not been selected randomly. Only doctoral programs named by participants of the study on researchers' experiences were analyzed. This approach seemed appropriate since there is no consistently used definition of doctoral programs and the GSHC (2023) stated their recommendation of a consistent definition for improving comparable statistics of doctoral programs after data collection (GSHC, 2023). Therefore, the sample of doctoral programs was somewhat pre-selected. However, on the basis of a sample size of 82 doctoral programs with various disciplinary backgrounds (medical, medical-natural science, natural science programs) and different forms of doctoral programs (ranging from more general doctoral programs to programs on a specific topic) it can be

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<sup>6</sup> I translated the original German quote into English.

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assumed that suggestions resulting from analyses of these doctoral programs can be generalized and are interesting for an international and interdisciplinary audience.

Second, this study is limited because the *E-Prom*-research group newly developed ad hoc scales for the surveys in the study on researchers' experiences which have not yet been validated (perceived support of competence, perceived support of autonomy, social relatedness to the scientific community, scholarly identity, academic career aspirations, research-related enjoyment, anger, frustration, and boredom). Van der Linden and colleagues (2018) developed and tested a short scale on need support and need satisfaction during doctoral studies. This scale could have been useful for this dissertation. However, surveying participants (the study on researchers' experiences started in 2014) took place before the research group of van der Linden published their scales in 2018 (van der Linden et al., 2018). All used ad hoc scales were developed thoroughly on the basis of theories and previous studies: the three scales on the basic needs for competence, autonomy, and social relatedness were developed on the basis of theoretical assumptions of SDT adapted to the specific context of academia for ecological validity (Deci & Ryan, 2012b; Vansteenkiste et al., 2020). For Publication II, scales on perceived competence and autonomy support as well as on social relatedness were phrased in the past capturing researchers' experiences during doctoral studies in retrospect<sup>7</sup>. For Publication III, these scales were adjusted on current experiences phrased in the present. For improving the quality of the scale on perceived autonomy support, this scale was extended from a three-item scale (Publication II, Cronbach's Alpha of  $\alpha = .65$ ) to an eight-item scale resulting in an enhanced Cronbach's Alpha of  $\alpha = .86$  in analyses of Publication III. The scale on scholarly identity was developed on the basis of assumptions of scholarly identity (Pyhältö, Nummenmaa et al., 2012) and inspired by a measurement on vocational identity (Porfeli et al., 2011)<sup>8</sup>. The study of Berweger and Keller (2005) on influencing factors in academic career aspirations of doctoral candidates served as a basis for the items of the academic career aspirations scale (Berweger & Keller, 2005). Lastly, the four scales on the research-related achievement emotions enjoyment, anger, frustration, and boredom were developed on the basis of assumptions of CVT (Pekrun, 2006, 2019) and on structures of the Achievement Emotion Questionnaire (Pekrun et al., 2002, 2005, 2011). Here, the items were adapted again to the specific academic context for ecological validity. However, the scales on anger and boredom had to be excluded from analyses because the variables could not be properly separated in factor

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<sup>7</sup> Full lists of items for the scales on basic needs in retrospect are available online. Autonomy support (<https://osf.io/62ntx>), competence support (<https://osf.io/g7vfx>), and social relatedness to the scientific community (<https://osf.io/fcq9b>).

<sup>8</sup> A full list of items for the scale on scholarly identity is available online (<https://osf.io/73zsc>).

analyses and variance was missing as described in Publication III. Hence, validity of all scales had not been tested yet, objectivity and reliability (satisfactory Cronbach's Alpha-values ranging between  $\alpha = .65$  and  $\alpha = .92$  (Neuhaus & Braun, 2007)) of the used scales had been met. Furthermore, the factorial structure of the remaining scales indicated separable factors for each theoretically assumed variable included in the analyses.

Third, it should be considered that the three basic needs are not measured at the same level. While the need for competence and the need for autonomy were measured at the level of perceived need support, the need for social relatedness was measured at the level of perceived need satisfaction. Nevertheless, results on the basic needs are interesting and comparable from previous empirical evidence on reciprocal effects between need support and need satisfaction in a longitudinal study (Olafsen et al., 2018).

### 4.4 Further research

The results and limitations of this doctoral thesis lead to further research. On the basis of the shortfalls in doctoral education in the analyzed doctoral programs (see section 4.1.1), further research on doctoral programs is needed. Research could analyze regulations in doctoral programs of other countries and other disciplines using the suggested definition of doctoral programs (GSHC, 2023). Comparisons with results of this dissertation would be useful to derive further suggestions on improving doctoral education internationally and independently from the research field. However, further research should take into account that high level of structure in doctoral programs could put central aims of doctoral education (autonomy and self-responsibility in research) at risk (GSHC, 2023). This recommendation emphasizes the relevance of further comparing recommendations of policy and their implementation in regulations of doctoral programs.

Since the used scales in this study were ad hoc scales, it would be useful to compare results of this doctoral thesis with further research on basic needs during the doctorate using the scales of this study in other contexts and countries as well as using tested scales, like the scales of van der Linden and colleagues (2018). Furthermore, it would be useful to transfer existing scales for doctoral studies on later career stages (van der Linden et al., 2018). Further research with transferred scales on basic needs in postdoctoral, independent, and professorial research phases could be compared with the results of Publication III.

Results of Publication III had already hinted that emotional experiences and academic positions were associated when PIs and research assistants differed in their experienced enjoyment. Further research on how to foster positive emotional experiences of researchers in academia considering their academic position is needed (for example, in intervention studies).



Little is known about which characteristics of these academic positions led to the differences in their emotional experiences. Future research should take particular positions' characteristics into account to derive more in-depth implications for academia. Additionally, further research considering a mixed methods approach (Hense, 2017), could include qualitative studies besides quantitative studies. Since optional comments on the quantitative survey indicate various reasons for experienced achievement emotions (frustration on publication delay, enjoyment of teaching and research progress) (see section 4.2), additional qualitative approaches could provide deeper insights in further predictors of emotional experiences in different academic positions and their relationship with the investigated basic needs as predictors.

Although gender discrimination is one of the key issues in academia (see section 1.2), analyses on gender differences in experiencing basic needs, scholarly identity, achievement emotions or career aspirations did not reveal notable gender-related differences (Publication II and III). However, owing to gender-related results in other studies showing, for example, particular emotional strain or less benefits from social relatedness for female researchers (e.g., Aitchison & Mowbray, 2013; Epstein & Lachmann, 2018), further research should investigate gender discrimination and following differences in research experiences of male, female, and diverse researchers.

Lastly, this doctoral thesis provided evidence that both individual and institutional factors are relevant in academic research careers (see figure 8). However, results of this study refer to a German sample of graduated life scientists. Further research in other research fields (such as human sciences) and in samples of other nations (such as the United States of America) would be useful to compare and validate these findings.

### **4.5 Implications**

This doctoral thesis was aimed at investigating individual and institutional factors related to academic research careers using samples of life science doctoral graduates in Germany. Although the investigated samples are limited owing to nationality and the research field, some theoretical and practical implications can be derived valid for an interdisciplinary and international audience: since life science is an interdisciplinary conglomerate of several research fields (biology and its subfields, medicine and its subfields, chemistry, among others) investigating life often in interdisciplinary cooperation (for example, with other life science fields and social sciences (with psychologists, sociologists, educational researchers, teachers, among others)), it can be assumed that implications of this study are interesting for other disciplines as well. Furthermore, the analyses on individual factors were embedded in internationally recognized psychological theories (SDT, CVT, professional identity). Par-

ticularly, on the basis of the assumption of universality of both basic needs within SDT (Vansteenkiste et al., 2020) and achievement emotions within CVT (Pekrun, 2019), it can be suggested that implications of this study are interesting for an international audience. In the following sections, first, theoretical implications for the investigated theories are derived. Additionally, the eRCCF is elaborated considering empirical evidence of this doctoral thesis (see section 4.6.1). Second, practical implications for improving doctoral education and further research phases are derived (see section 4.6.2).

#### 4.5.1 Theoretical implications

The section on theoretical implications is divided into two parts: first, (I) implications for the psychological theories SDT, CVT, and on professional identity are described. Second, (II) implications for the eRCCF and further research on academic research careers are elaborated. A revised eRCCF is derived.

(I) Results of this thesis support the assumption of SDT that basic needs are universal (Vansteenkiste et al., 2020). The results showed that basic needs are valid in higher education contexts after basic studies, in a German context, and in the research field of life sciences. BPNT as a mini-theory within SDT assumes that basic needs support has a long-term effect on several outcomes (such as on need satisfaction, healthy personality development, well-being, identity, and achievement emotions) (Deci & Ryan, 2002, 2012b; Flunger et al., 2013; Luyckx et al., 2009; Olafsen et al., 2018). Findings of this doctoral thesis partially support assumptions of BPNT and related research results when satisfied social relatedness was associated with scholarly identity and career aspirations over time but support of autonomy and competence were not (Publication II).

Addressing the basic needs individually, it should be considered that relationships with other researchers in scientific communities may provide both support and competition. Researchers in scientific communities who share similar research interests and comparable research experiences may support each other during research as well as compete for the same positions in academia. Nevertheless, social relatedness is a crucial factor at all career stages because it explained career aspirations across career stages and positive emotional experiences in research (Publication II and III). Whereas, autonomy and competence seem to be more relevant in later career stages after doctoral graduation when researchers had already developed and professionalized themselves as scholars (Publication II and III). Missing associations of autonomy and competence support with identity and career aspirations as well as simultaneously intercorrelation of competence support and social relatedness in the mediation model of Publication II hinted that relationships of the three basic needs are complex in the

context of academia. Research results on secondary school students supports this assumption when autonomy support is positively associated with several outcomes (such as vitality, contentment, and academic achievement), while this association is mediated by relatedness and perceived competence (Martinek et al., 2022). Furthermore, PhD candidates show their competence through acting autonomous in researching (Janssen et al., 2020). Thus, studies of Martinek and colleagues (2022) as well as Janssen and colleagues (2020) support the assumption made in Publication II, that basic needs are not only adjacent to each other but may also be hierarchically linked. The complexity of basic needs, especially in the context of academic research careers, seems not to be sufficiently understood yet and should be further investigated.

Results of Publication II and Publication III had provided evidence for the appropriateness of an SDT-approach to capture researchers' experiences in academia as individual-level antecedents explaining academic career aspirations. Particularly, social relatedness to the scientific community was a relevant factor during both the first career phase (doctoral studies) as well as later ones (postdoctoral, independent, and professorial research) while competence and autonomy support were mainly relevant at later career stages. Thus, compiling the eRCCF with assumptions of the SDT was beneficial for explaining how individual preferences develop. Beyond previous SDT-research in school, sports, higher education (undergraduate students), and vocation, among others (Daniels et al., 2021; Olafsen et al., 2018; Vallerand et al., 1997; Vermote et al., 2020), research on academic research careers can be assumed as a further research field where SDT can be applied to.

In higher education contexts, there have already been initial approaches capturing the complexity of experiences during doctoral studies using an SDT-approach besides studies on undergraduate students (e.g., Daniels et al., 2021). Van der Linden and colleagues (2018) developed basic needs support and basic needs satisfaction short scales capturing experiences in the context of doctoral studies as basic needs (van der Linden et al., 2018). However, SDT-based investigations of how researchers experience the support of their basic needs during later academic research career phases are rare. With findings on both doctoral studies and academic phases after doctoral graduation, this research gap was addressed in this dissertation.

Additionally, results of Publication II supported the validity of scholarly identity as the relevant identity facet of professional identity in academic contexts (Pyhältö, Nummenmaa et al., 2012). With the German sample of doctoral graduates in the life sciences, this study extended the validity of scholarly identity, first described in Finish samples of doctoral

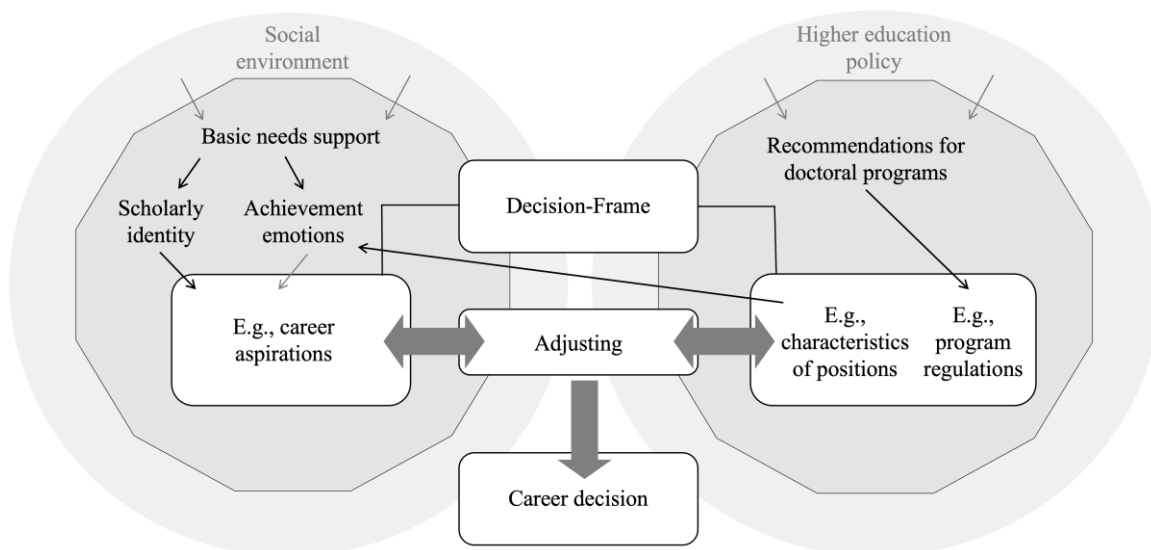
candidates (Pyhältö, Nummenmaa et al., 2012), to another nationality and a later career stage after doctoral graduation (postdoctoral research).

Results of Publication III showed that emotional experiences in academia can be gauged as achievement emotions in the context of postdoctoral, independent, and professorial research phases using a CVT-approach. However, the scales on research-related anger and boredom did not gauge the emotional experiences of researchers during these career phases in an optimal way and results had to be excluded from further analysis. Nevertheless, it can be assumed that investigating emotional experiences in academia as achievement emotions using a CVT-approach is beneficial on the basis of the results on enjoyment and frustration. The scales on anger and boredom should be improved and tested in further research. In summary, academic research careers and their different career stages can be added to the fields of CVT-application beyond, for example, school (e.g., Flunger et al., 2013; Pekrun, 2006) and higher education (e.g., Pekrun & Stephens, 2010).

Previous studies on career decisions in academic research careers focused mostly on sociological approaches to examine factors influencing career decisions in academia (see section 1.2.1). Empirical evidence of this doctoral thesis for the validity and relevance of basic needs throughout the career stages to explain scholarly identity, achievement emotions, and career aspirations (Publication II and III) hints that psychological investigations on career decisions in academia considering basic needs, scholarly identity, and achievement emotions could be a further promising approach for research on different career stages. This leads to the compiled eRCCF: in the eRCCF sociological and psychological approaches are combined for converging on researchers' diverse experiences in academia influencing academic research career decisions as described in the following paragraphs.

(II) Academia wants to keep talented scientists in academic career paths in order to maintain a sufficient pool of adequate qualified researchers to select the best scientists as professors from this pool (Krempkow, 2017). Therefore, studies on researchers' career decisions are highly relevant for higher education policy makers. This doctoral study was to address this need through examining both institutional and individual factors influencing academic research careers. For comprehensively examining academic research careers in the life sciences from different perspectives, descriptive and analytical approaches as well as longitudinal analyses and cross-sectional investigations were combined. Furthermore, various career stages within academic research career progress were investigated in this thesis (see figure 8). Results of this study have been discussed considering the RCCF of Cañibano and colleagues (2019) to embed them in up-to-date research on academic research careers. The

RCCF suggests that individual preferences and institutional conditions are adjusted to make a career decision in academia (Cañibano et al., 2019). Since these factors are expected to have antecedents (see section 1.), the RCCF was theoretically extended to the eRCCF in this thesis. Individual-level antecedents influencing individual preferences and structural antecedents relevant for changes in institutional conditions were integrated in the eRCCF (see figure 1). Furthermore, the results of this doctoral thesis lead to an enhanced eRCCF: empirical findings of this thesis on particular variables are incorporated in the eRCCF to specify the framework. The enhanced eRCCF shows how specific individual preferences, their individual-level antecedents as well as specific institutional conditions and their structural antecedents are related to each other in order to explain the decision to pursue or quit an academic research career (see figure 9).



**Figure 9. The enhanced eRCCF—integrating empirical indications.** On the left side, findings of this study empirically imply that individual preferences (here academic career aspirations) are associated with individual-level antecedents (basic needs, scholarly identity, and achievement emotions). On the right side, institutional conditions (here regulations of doctoral programs) are associated with structural antecedents (recommendations of policy on doctoral programs) although they are not fully in alignment. Institutional conditions (characteristics of academic positions as research assistant or PI) are related to individual-level antecedents (some achievement emotions). Black arrows indicate first empirical hints on associations provided by this dissertation. Grey arrows indicate not yet analyzed but theoretically suggested and in previous research shown associations relevant for the overall connection of this extended framework (e.g., the association of achievement emotions and career aspirations has been shown in other contexts (Basarkod et al., 2023; Fisher & Ashkanasy, 2000; Pekrun et al., 2023; Robinson et al., 2020; Weiss & Cropanzano, 1996)).

On the right side of the eRCCF (see figure 9), institutional conditions are relevant in explaining academic career decisions (Cañibano et al., 2019). Owing to the definition in the original framework of the RCCF, this means, that the conditions of an institution are characterized by national (in Germany, doctoral education is typically not shaped by a course

curriculum but focuses on first independent research) and by field-specific particularities (medical doctoral studies mostly start during basic studies) (Cañibano et al., 2019; GSHC, 2011a). However, structural antecedents of these institutional conditions are added in the eRCCF because changes in institutional conditions are mostly driven by recommendations of policy as structural antecedents. In Germany, for example, recommendations of policy drove changes in institutional conditions of doctoral education when more doctoral programs were implemented following several recommendations (e.g., HRK, 2012; GSHC, 2023). To evaluate the suggested relationship of structural antecedents and institutional conditions, structural antecedents in form of recommendations of policy were compared with regulations in doctoral programs (institutional conditions) in Publication I. Findings indicate that structural antecedents may change institutional conditions although changes in institutional conditions of doctoral programs were incomplete (see section 4.1.1). Thus, explaining career decisions is more complex than previously assumed in the original RCCF (Cañibano et al., 2019) because institutional conditions are dynamic and higher education policy as an underlying structure imprint changes in these conditions through recommendations (structural antecedents).

On the left side of the eRCCF (see figure 9), individual preferences (like academic career aspirations) are suggested to explain career decisions in addition to institutional conditions and their antecedents (Cañibano et al., 2019). However, previous research indicated that preferring a specific career path as individual preference is associated with individual-level antecedents (e.g., Ortlieb & Weiss, 2018). Therefore, particular individual-level antecedents were examined in Publication II and III: a competence and autonomy-supportive environment in academia, social relatedness to the scientific community as well as their relationship to scholarly identity and achievement emotions. Furthermore, associations of individual-level antecedents with individual preferences of pursuing an academic research career were investigated. The individual-level antecedents of basic needs, scholarly identity, and achievement emotions were linked together emphasizing that underlying structures of career aspirations and decisions are highly complex. The social environment providing support for some individual-level antecedents (like the basic needs) is a crucial factor in explaining academic career decisions as described in the eRCCF (see figure 9).

Since both the social environment and higher education policy as underlying structures dynamically influence individual preferences and institutional conditions, decision-making processes are assumed to be complex and related to characteristics of a specific time point. Changes in the social environment (for example, when the supervising professor get appointed to another professorship position at another university, colleagues get positions at another

university, or researchers of the scientific community retire) may change characteristics of the linkages between the individual-level antecedents and individual preferences (for example, when the change in the social environment results in less satisfied relatedness to the scientific community which cause a reduced identification as a scholar and a decreased aspiration to stay in academia). This dynamic relationship applies to institutional conditions and their structural antecedents likewise (for example, when policy recommend that doctoral candidates should be given the opportunity of being examined online via a video tool during a pandemic resulting in new home office infrastructures as institutional condition). The dynamics of the factors within the eRCCF should be further investigated in future research, for example, in intervention and in further longitudinal studies.

The cross-link of institutional conditions (characteristics of academic positions) and individual-level antecedents (achievement emotions) indicates that relationships within the eRCCF are more complex than previously suggested. Therefore, it can be assumed that both individual (left side of the eRCCF) and institutional factors (right side of the eRCCF) influence each other mutually before they interact when researchers adjust their individual preferences and institutional conditions for making a career decision (Cañibano et al., 2019).

The eRCCF is intended to serve as a tool for further research investigating the complexity of career decisions in academia in more detail. However, it should be considered that career decisions are always made individually and such a framework can only be an approximation towards complex reality. Nevertheless, this framework helps not only to explain the direct determinants of career decisions (individual preferences and institutional conditions of the RCCF (Cañibano et al., 2019)), but also to understand which factors (individual-level and structural antecedents of the eRCCF) influence them. Further research should examine associations of the eRCCF that have not been analyzed yet: the association of achievement emotions and career aspirations is assumed owing to previous research in other contexts (Fisher & Ashkanasy, 2000; Pekrun et al., 2023; Robinson et al., 2020; Weiss & Cropanzano, 1996). Further studies should prove this association in the context of academic research careers considering different career stages. Furthermore, the influence of the social environment on individual-level antecedents (such as basic needs) suggested owing to research results and theoretical assumptions of SDT (e.g., Deci & Ryan, 2002; 2012b) should be further investigated. In this dissertation, mainly the scientific community as an agent of the social environment in academia was considered. However, previous research emphasized the relevance of the researchers' relationship to other agents for academic career aspirations (for example, postdocs' relationship to the supervising professor (Epstein & Elhalaby, 2023)).

Therefore, researchers' relationships to different agents of the social environment should be investigated to explain career decisions in more detail (such as the local working group, the supervising professor). In the interdisciplinary life sciences, the research field of the agents should be considered because previous research suggested that there are difficulties during interdisciplinary writing processes (Doody, 2020). Additionally, future research should examine further institutional conditions since this dissertation investigated a selected range of institutional conditions. As described in section 1.1 and 1.2, there are several institutional conditions which may hamper academic research careers (like the availability of a desired position or less favorable working conditions in fixed-term contracts). The eRCCF provides an approach to investigate the impact of such issues on career decisions. Since the findings of this doctoral thesis indicate that the eRCCF can be applied to all stages of an academic research career (see figure 8), future research should further evaluate investigations of researchers' career decisions at different career stages using the eRCCF. In summary, examining the individual preferences and institutional conditions considering their antecedents using the eRCCF may provide more detailed information on complex decision-making processes of researchers to understand how to keep talented scientists in academia.

More detailed research on academic research careers using the eRCCF may allow higher education policy to derive further recommendations as structural antecedents for improving institutional conditions. This leads to practical implications explained in the following section.

#### **4.5.2 Practical implications**

Some practical implications on (1) institutional and (2) individual factors for improving doctoral education and further stages of academic research careers can be derived from the results of this doctoral study.

(1) Results of Publication I implicate that further improvements of doctoral programs would be beneficial as one possibility of educating and training doctoral candidates among others (like the traditional master-apprentice model) (Schneijderberg, 2018, 2019). Particularly, international orientation, a broader offer of courses, more structured supervision, and alternative examination approaches in doctoral programs should be further enhanced. Previous recommendations of policy should be implemented in more doctoral programs in the life sciences. Whereas a current recommendation of higher education policy should be considered that structuring doctoral education is only appropriate to a certain extent to avoid putting the development of autonomous and self-responsible research at risk (GSHC, 2023). Further research should investigate why previous recommendations were not fully implemented in doctoral programs' regulations considering underlying infrastructure of the universities which



may already provide some structures or offers (see section 4.1.1). Nevertheless, higher education policy should further state recommendations to the current status of institutional conditions in doctoral education based on empirical studies like this dissertation and national reports (e.g., BuWiN) among others (see section 1.2.2). Regularly, higher education research should review the implementation of such recommendations for advancement in institutional conditions (for example, with panel surveys such as the NACAPS (NACAPS Website)). Descriptive studies investigating the regulations in doctoral programs could complement such surveys on doctoral candidates' experiences because previous research implied that candidates' experiences are not fully in alignment with regulations (Lachmann et al., 2020). Although experiences of doctoral candidates in doctoral programs should be finally improved, regulations of doctoral programs should be enhanced as an intermediate step. If improvements in doctoral education are not set by regulations, then doctoral candidates' experiences could probably drift apart and dependence on willingness of the supervisors to put effort in supervision may increase again. Central aims of doctoral education could be transferred into the hidden curriculum (Elliot et al., 2020) and obligation of the aims could decrease. For example, new doctoral candidates may not realize that publishing open access is important for their future careers considering the idea of open science (Creaser, 2010; Vicente-Saez & Martinez-Fuentes, 2018). However, if the training of this skill shifts to the hidden curriculum because doctoral programs do not explicitly teach it, some doctoral students may be at risk of developing a shortcoming in this skill while others may not.

(2) Findings of Publication II and III indicate that basic needs are crucial individual-level antecedents influencing several further factors which explain career decisions (see figure 9). With opportunities for a good relatedness to scientific communities, doctoral graduates are more likely to identify as scholars and to aspire an academic career path. After doctoral graduation, well networked researchers are more likely to perceive enjoyment during research. Therefore, supporting researchers in their basic need of social relatedness is beneficial for keeping them in academia. Although competence and autonomy support during doctoral studies seemed to be less relevant in explaining scholarly identity and career aspirations, supporting the basic needs of competence and autonomy in doctoral graduates is associated with positive emotional patterns (less frustration, more enjoyment). Research assistants experience less enjoyment than PIs. Since previous research has provided evidence that emotions' antecedents can be fostered for positive emotional experiences (Tze et al., 2022), providing opportunities for and promoting antecedents of enjoyment are useful: research assistants could be supported to conduct independent research through the possibility to acquire own research projects

(autonomy support), to handle efficiently criticisms of peer review during publication processes through improving the own manuscripts and related research (competence support), and to network efficiently and sustainably during conferences or other events (social relatedness to the scientific community).

Fostering merely supportive structures in the social environment would fall short for keeping researchers in academia because institutional conditions in academia are the second pillar in complex career decisions as stated in the eRCCF (see figure 9). Nevertheless, academia could increase offers for further personal leadership skills, team building opportunities, and communication in research teams as personal development offers to provide support for researchers (Krempkow & Winde, 2016). Current investigations on personal development in academia have already indicated that academia uses such offers increasingly for managing academic staff and their further training (BuWiN, 2021). However, there is still a need for further research to evaluate the impact of supporting offers on researchers' career decisions using the eRCCF (see figure 9).

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## 6. Abbreviations

ÄAPPO	Approbation regulations for physicians
Basic needs	Basic psychological needs
BMBF	Federal Ministry for Education and Research
BuWiN	National report on junior scholars
BPNT	Basic Psychological Needs Theory
CfLPM	Center of Leadership and People Management
CVT	Control-Value Theory
DFG	German Research Foundation
Doctoral programs	Structured doctoral training programs
EC	European Commission
eRCCF	extended Research Career Conceptual Framework
ESF	European Science Foundation
GSHC	German Science and Humanities Council
GWK	Joint Science Conference
HRK	German Rectors' Conference
IRTG	Integrated Research Training Group
LMU	Ludwig-Maximilians-Universität München
NACAPS	National Academics Panel Study
PI	Principal investigator
Postdoc	Postdoctoral researcher
PROFiL	Professional teaching
RCCF	Research Career Conceptual Framework
SCCT	Social Cognitive Career Theory
SDT	Self-Determination Theory
TAC	Thesis advisory committee
WissZeitVG	Law on fixed-term contracts in academia
WiNbus	An online panel for young scientists in Germany

## **Eidesstattliche Erklärung**

Ich versichere hiermit an Eides statt, dass die vorgelegte Dissertation von mir selbstständig und ohne unerlaubte Hilfe angefertigt ist.

Düsseldorf, den 11.08.2023

.....Julia S. Meuleners.....

## **Erklärung**

Hiermit erkläre ich,

dass die Dissertation nicht ganz oder in wesentlichen Teilen einer anderen Prüfungskommission vorgelegt worden ist.

dass ich mich anderweitig einer Doktorprüfung ohne Erfolg nicht unterzogen habe.

Düsseldorf, den 11.08.2023

.....Julia S. Meuleners.....