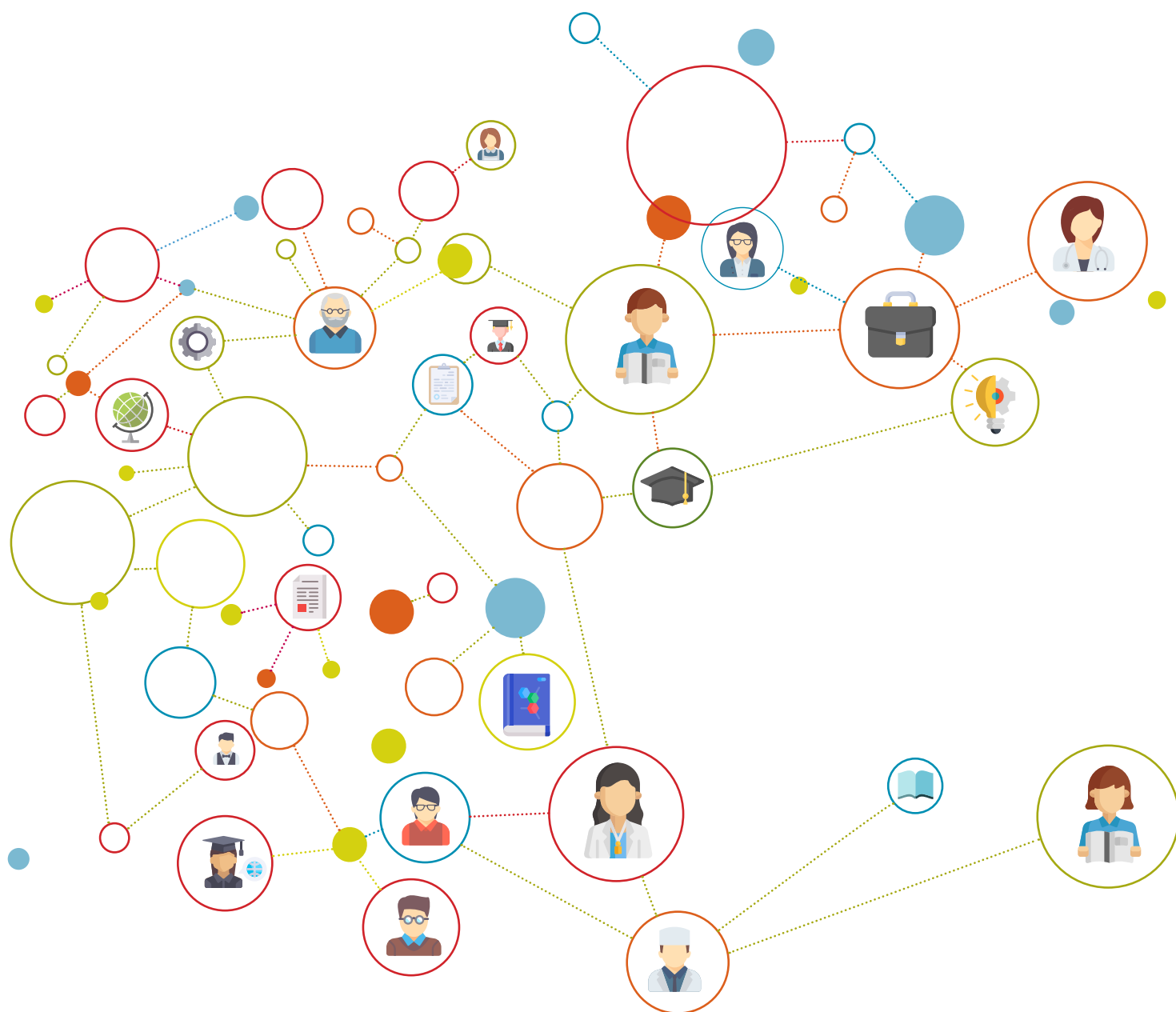The Future
of PhD
Holders

Education-job match among PhD holders
in the Federation Wallonia-Brussels

With the support of the

Observatory of Research and Scientific Careers - F.R.S.-FNRS

Thanks to funding from the Federation Wallonia-Brussels (FWB), the Observatory of Research and Scientific Careers was created in September 2018. Integrated in the F.R.S.-FNRS, this structure aims, among other things, to track and analyse the careers of researchers in the FWB through surveys and data cross-referencing. In collaboration with the six FWB universities, the Observatory is responsible for developing knowledge on the doctoral and postdoctoral process. It makes recommendations to facilitate the professional transition of PhD holders and optimise the doctoral process in order to meet the expectations of researchers and society. Particular attention is paid to the various obstacles to a scientific career: stereotypes and discrimination related to gender, constraints related to the requirement of international mobility, impact of the pressure to publish early in one's career, etc. The results of surveys and analyses are systematically published on the site: http://www.observatoire.frs-fnrs.be

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Executive Summary

PhD holders, as highly qualified manpower, are considered to be particularly strategic for knowledge production, diffusion, and innovation in modern knowledge-based economies. If PhD holders are unable to find jobs that require a PhD degree within their research domain (education mismatch) or do not have the opportunity to apply the skills they acquired before and during their doctoral training (skills mismatch), the strategic roles that they can play in knowledge production and, consequently, their added value for economic growth will be compromised. It is therefore important to analyse the education-job match among PhD holders in the FWB.

Consequently, using the "Future of PhD Holders" survey data, the primary aim of this report is to describe the education-job match of PhD holders at the time of the survey, based on (1) the time they spend on research and development (R&D) activities in the workplace, (2) how their position relates to their research domain, (3) the minimum level of qualification required for their job, (4) their level of salary, and (5) the match between the skills they acquired before and during their doctoral training and the skills they use in the workplace.

- **Time spent on R&D activities.** 69.7% of PhD holders spend at least 30% of their time in the workplace on R&D activities. Time spent on R&D activities depends on the sector of employment: PhD holders who work in the university sector, the government/public sector and industry spend more time on R&D activities compared to those in other sectors of employment (e.g., service, education outside higher education, etc.).

- **Relation of the position to the research domain**. A vast majority of PhD holders (86.3%) have positions that are related or somehow related to their research domain.

- **Minimum level of qualification required for the position**. There are clear differences in the level of qualification required by sector of employment. Only 34.5% of PhD holders who work outside the university sector hold positions that require a PhD degree or a postdoctorate. PhD holders in Social Sciences and Humanities have the highest rate of *overeducation,* with 78.1% holding positions that require a Master's degree or less. This rate is 63.7% in Exact and Natural Sciences and 57.9% in Life and Health Sciences.

- **Level of salary**. A very large majority of full-time employees in Belgium (75.1%) earn between €2,001-€3,000 net monthly. The level of salary, determined by the range of net monthly earnings, varies significantly by gender and years since doctoral completion.

- **Acquired skills**. The three skills that are considered as acquired by most PhD holders are "critical and analytical thinking", "research skills", and "scientific and technical expertise". On the other hand, three skills that are ranked as not acquired (or only partially acquired) by most PhD holders are "business skills", "collaboration and team work", and "social skills and multicultural competency".

- **Used skills.** The three skills that PhD holders use most in the workplace are "initiative and autonomy", "communication" and "critical and analytical thinking".

> **Match between acquired and used skills.**

Skills not acquired but used. For PhD holders working outside the university sector (*n* = 1143) three important skills have been identified which are not acquired but used. By order of importance these skills are "collaboration and team work", "business skills" and "social skills and multicultural competency". For those working in the university sector (*n* = 912), these skills are "collaboration and team work", "social skills and multicultural competency", and "project management".

Skills acquired but not used. Most PhD holders, independent of their sector of employment, use almost all the skills they acquired before and during their doctoral training in the workplace.

An analysis of the education-job match of PhD holders in the FWB has produced encouraging results regarding the match between the training PhD holders received and their work, but also points to some challenges they face. The Observatory will continue to publish similar reports based on the data collected through the "Future of PhD Holders" survey.

1. INTRODUCTION

In modern knowledge-based economies, human capital is an important driver of economic growth (Cohen & Soto, 2007). PhD holders, as highly qualified manpower, are therefore considered to be particularly strategic for knowledge production, diffusion, and innovation (Auriol, 2010; García-Quevedo, Pellegrino, & Vivarelli, 2014; Herrera & Nieto, 2015; Salter & Martin, 2001). PhD holders can play three important roles when they join a non-academic sector. Firstly, they are a primary source of knowledge. They bring information about recent scientific research, an ability to solve complex problems, and advanced research skills (Mangematin, & Robin, 2003; Salter & Martin, 2001). Secondly, they enhance an organisation's ability to assimilate and exploit external information, known as the 'absorptive capacity' (Cohen & Levinthal, 1990). And finally, they play a connective role, which facilitates tacit knowledge and technology transfer from universities to non-academic sectors (Herrera & Nieto, 2015; Hess & Rothaermel, 2011). Recognising the importance of these roles, in the last few decades, public authorities have supported policies that have led to a significant increase in the number of doctoral degrees awarded around the world (Gokhberg, Shmatko, & Auriol, 2016). Following this trend, in the Federation Wallonia-Brussels (FWB), the number of PhD degrees awarded almost doubled between 2000 and 2016 (Bebiroglu, Dethier & Ameryckx, 2019).

The return on this investment in human capital nevertheless depends on the education-job match (Bender & Heywood, 2009, 2011; Di Paolo & Mané, 2016). From a public policy perspective, the strategic roles that PhD holders can play in knowledge production, and consequently, their added value for economic growth will be compromised (1) if PhD holders are unable to find jobs that require a PhD degree within their domain of expertise (education mismatch) and (2) are not able to apply the skills they acquired before and during their doctoral training (skills mismatch). Moreover, a number of studies have suggested that education-job mismatch has several negative effects on the individual. For instance, mismatch is associated with a wage penalty (Bender & Heywood, 2009, 2011; Canal Domínguez & Rodríguez Gutiérrez, 2013), especially for women (Bender & Heywood, 2009; Nordin, Persson, Dan-Olof, 2008), lower job satisfaction (Allen & van der Velden, 2001; Garcia-Espejo & Ibanez, 2005; Green & Zhu, 2008) and lower job productivity (Adalet McGowan, & Andrews, 2015). There is thus a clear need to analyse the education-job match among PhD holders in the FWB.

In our first thematic report based on this survey, we described the employment status of PhD holders from all six French-speaking universities in Belgium by providing information on their employment/unemployment rate, professional status and sectors of employment. In the current report, our primary aim is to analyse the education-job match of PhD holders at the time of the survey. We start this report by briefly describing the sample characteristics and the procedure. We then detail the education-job match of PhD holders at the time of the survey based on (1) the time they spend on research and development (R&D) activities in the workplace, (2) how their position relates to their research domain, (3) the minimum level of qualification required for their job, (4) their level of salary, and (5) the match between the skills they acquired before and during their doctoral training and the skills they use in the workplace. We finish this report by summarising the main conclusions.

2. SAMPLE AND PROCEDURE

This report is based on data from the "Future of PhD holders" survey, which targeted PhD holders from all six French-speaking universities in Belgium. The survey was online from the 11th of December 2018 to the 31st of January 2019. The analyses of the current study are based on 2,055 participants (42.8% female). Respondents had an average age of 35.2 years (*SD* = 6.3) and had received their doctoral degree in the 3.1 years prior to the survey (*SD* = 1.9). 64.9% were of Belgian nationality and 38.8% were working outside of Belgium at the time of the survey. Most respondents (45.8%, *n* = 941) had their PhD in Exact and Natural Sciences (ENS), whereas 31.0% (*n* = 638) had theirs in Social Sciences and Humanities (SSH) and 29.9% (*n* = 476) in Life and Health Sciences (LHS).

Participants were recruited mostly through doctoral supervisors who were asked to transfer an invitation to their former doctoral students. The invitation to participate included a short description of the study, eligibility criteria for participation (i.e., having completed a PhD between January 2012 and May 2018 in one of the French-speaking universities in Belgium), and a hyperlink to the survey, which directed participants to SurveyGizmo, a secure online data collection software. Participants' data were automatically downloaded into a database for statistical analyses. Participation in this study was voluntary and anonymous. All participants provided consent after receiving information about the study. Please refer to our first report (Bebiroglu, et al., 2019) for more details about the sample characteristics and procedure.

Given that this report is on the education-job match among PhD holders, the sample to be used in this study included only respondents who had a job at the time of the survey and did not choose the "other" category for their professional status, which consists of 1,856 participants (43.3% female), representing 90.3% of the total sample[1].

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[1] With the exception of the question "To what extent did you acquire the following skills during your PhD?", which was asked to all PhD holders.

3. EDUCATION-JOB MATCH

3.1. Time spent on research and development activities

In the questionnaire, we asked PhD holders to indicate what percentage of their time in the workplace was spent on R&D activities (data collection, analysis, publication). Responses ranged from 0% to 100%. Figure 1 demonstrates that 41.8% of PhD holders spend between 60% and 100% of their time in the workplace on R&D activities. Only 30.3% of them spend less than 20% of their time in the workplace on R&D activities.

Figure 1. What percentage of your time in your current job is spent on research and development activities (data collection, analysis, publication, etc.)? (n = 1,856)
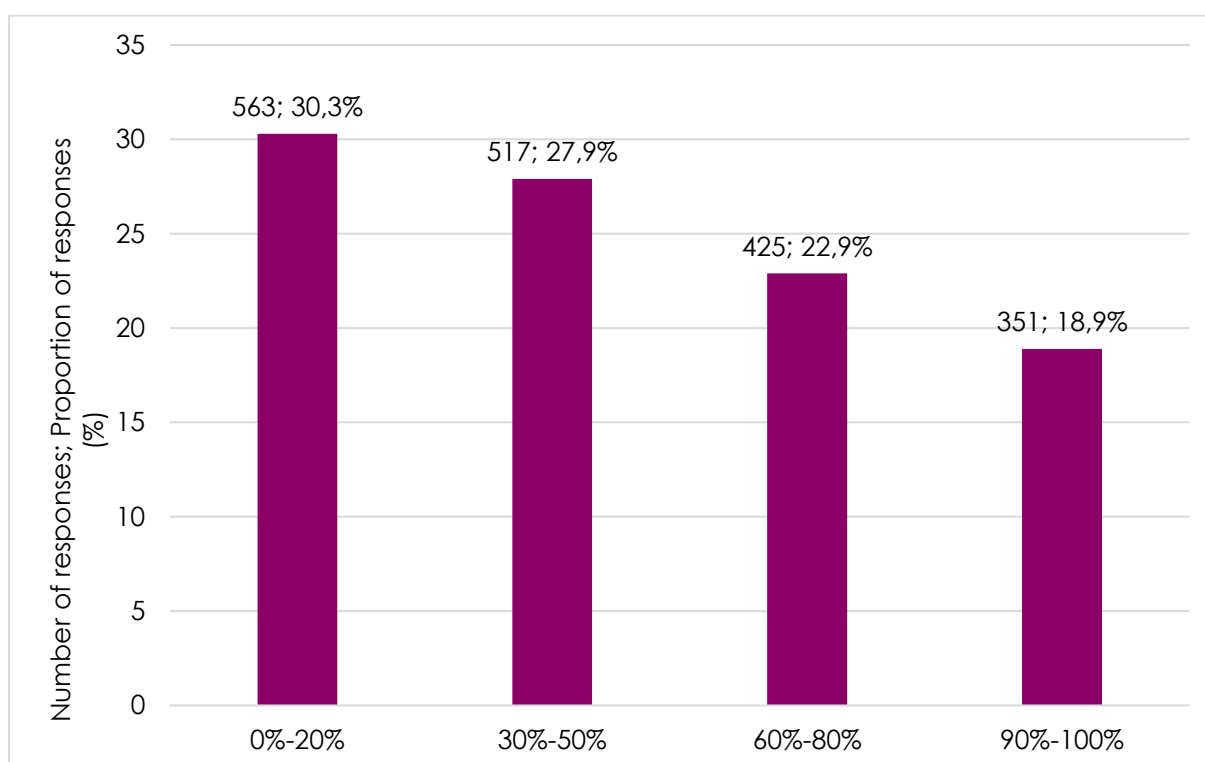

We asked those who engaged in R&D only 20% of their time or less why they chose a position with few research activities. A significant proportion (60.6%) stated that they could not find a position with more research activities (Figure 2). Therefore, it would seem that being less engaged in R&D is down to a lack of professional opportunities rather than by personal choice. PhD holders who could not find a position with more research activities (*n* = 341; 46.9% female) were equally distributed among the research domains[2]: 35.2% from ENS, 34.9% from SSH and 29.9% from LHS.

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[2] In the remainder of this report, the research domain refers to domains at doctoral level, namely Exact and Natural Sciences, Life and Health Sciences, and Social Sciences and Humanities.
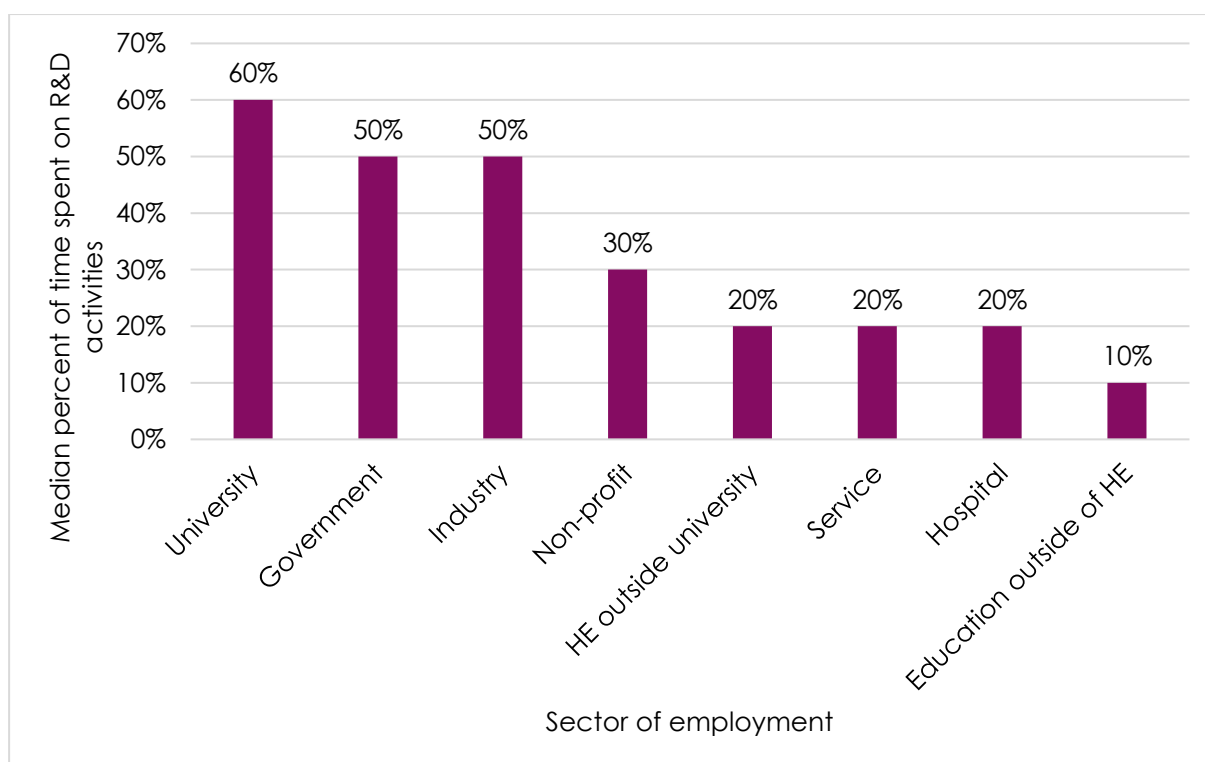
Figure 2. Why did you choose a position with few research activities? (n = 563)
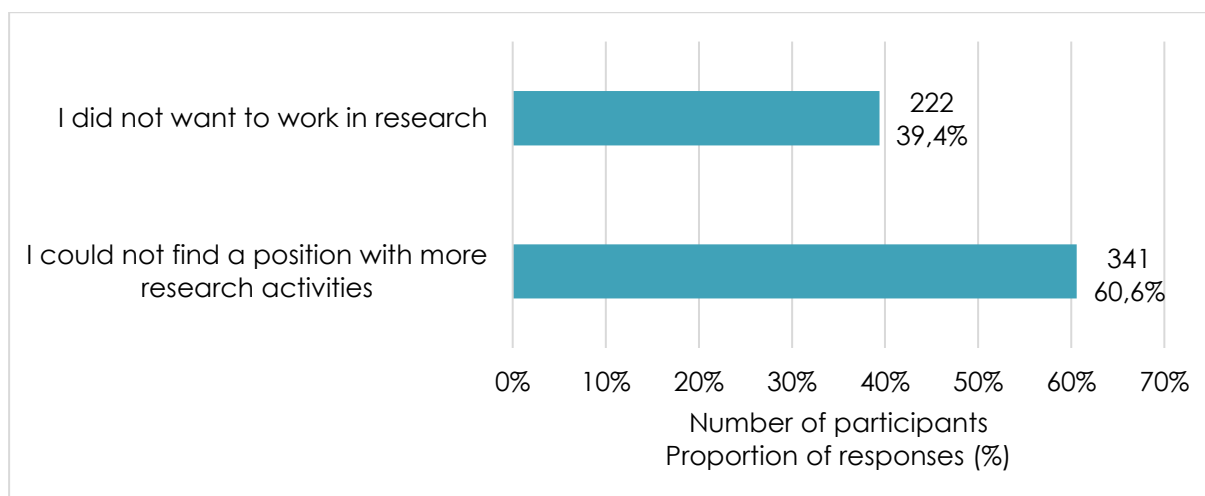
Time spent on R&D depends on the sector of employment: PhD holders who work in the university sector, the government/public sector and industry engage in more R&D activities than those who work in other sectors (Figure 3)[3].

Figure 3. Time spent on R&D activities by sector of employment (n = 1,856)

HE = Higher Education

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[3] For the question on the employment sector, respondents had the possibility of choosing more than one sector of employment. 217 PhD holders chose more than one sector.

The box plots below illustrate the percentage of time spent on R&D activities by research domain (Figure 4) and gender (Figure 5) within and outside the university sector. We observe that the median percentage of time devoted to R&D activities, represented by the horizontal line in each box, is systematically higher for the university sector independent of research domain and gender. Figure 4 shows that the median percentage of time spent on R&D is highest for PhD holders in ENS working in the university sector. Figure 5 shows that the percentage of time spent on R&D activities is similar for men and women outside the university sector.

Figure 4. Box plots depicting percentage of time spent on R&D activities by research domain within and outside the university sector
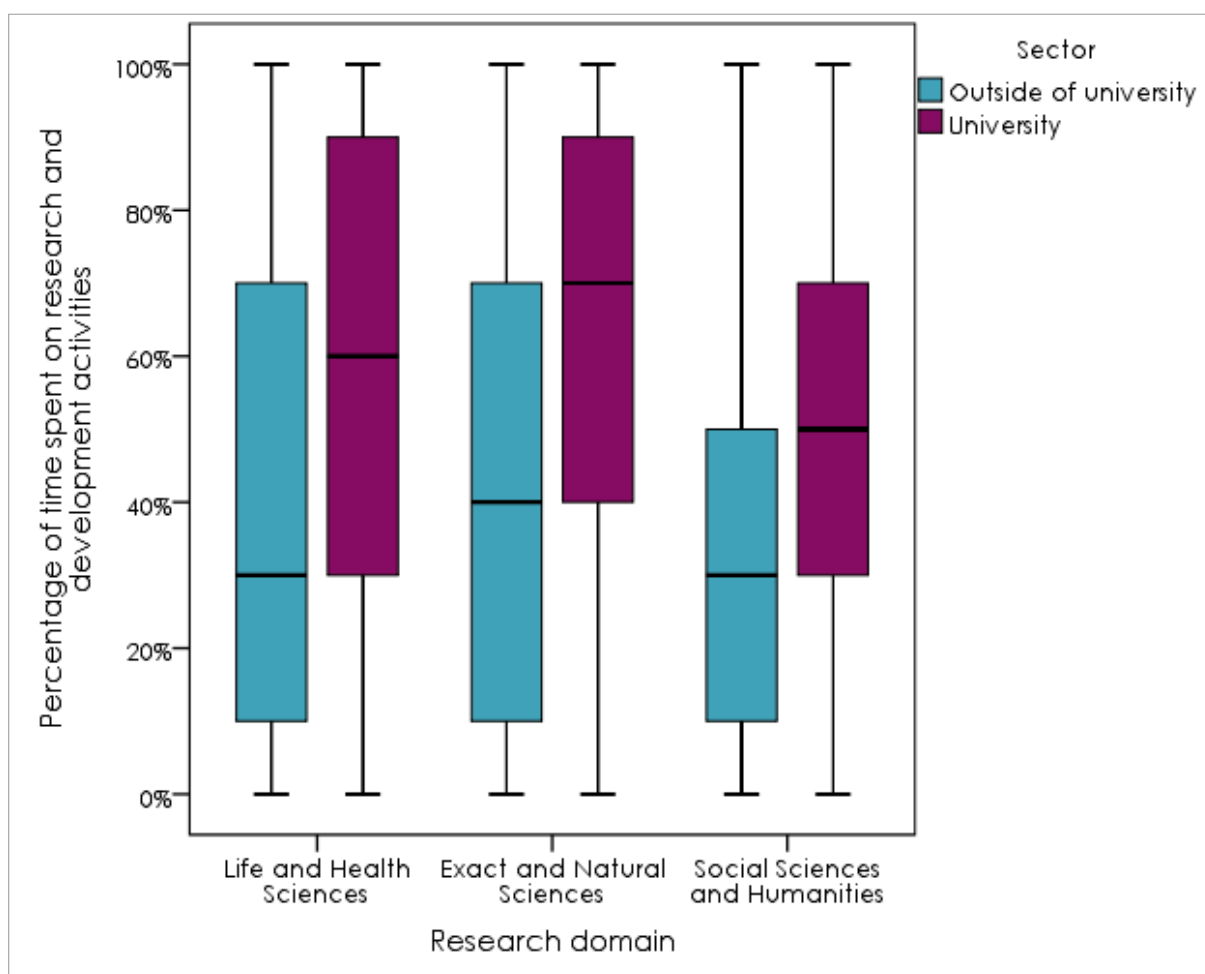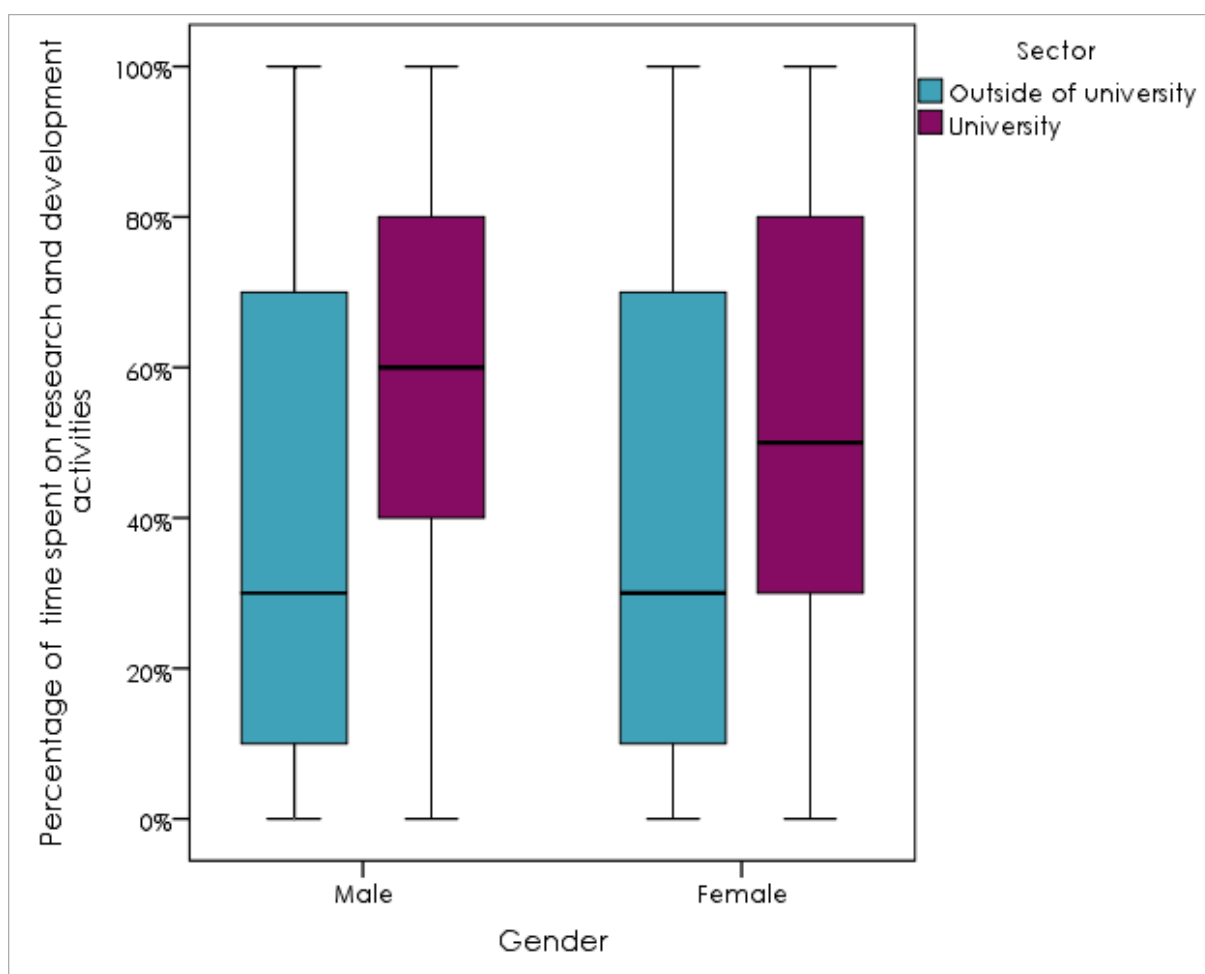
Figure 5. Box plots depicting percentage of time spent on R&D activities by gender within and outside the university sector

Time spent on R&D activities. In this model, for PhD holders with a job, we evaluated the probability of spending a higher percentage of their time on R&D activities. Based on the median percentage of time (50%), we categorised those who spent 50% or more of their time on R&D activities as the "high R&D group" (coded as 1) and those who spent less than 50% of their time as the "low R&D group" (coded as 0).

In order to check whether or not gender, research domain, having children, mobility, years since PhD completion, positive work environment during doctoral training, and sector of employment (university vs. outside of university) had a significant effect on the probability of being in the high R&D group, we performed a logistic regression analysis.

Mobility was measured by the question: "Did you work outside the FWB for more than three months after completing your PhD?, coded as 1 = Yes and 0 = No. The positive work environment during doctoral training was measured by taking the mean of four items: "During your PhD, in your immediate work environment (e.g., research laboratory), how much have you felt the presence of (a) kindness, (b) team spirit, (c) flexibility and adaptability, and (d) creativity". Respondents rated the presence of each characteristic on a five-point Likert scale (1 = not at all to 5 = very

strongly). All the details of this regression analysis as well as the tables are presented in the Appendix.

When we add gender, research domain, having children, mobility, years since PhD completion, positive work environment, sector, and interaction between sector and having children, the regression analyses demonstrate that, controlling for other factors:

(1) those who were in post-doctoral mobility are 1.69 times more likely to be in the high R&D group than those who were not [IC = 1.39-2.07];
(2) those in SSH and LHS are less likely to be in the high R&D group than doctoral graduates in ENS [For SSH: OR =, 58, CI =, 45-, 74; For LHS: OR =, 72, IC =, 56-, 93];
(3) each additional year since graduation decreases the probability of being in the high R&D group [OR = .93; IC =, 88-, 98];
(4) each increase of one unit in the positivity of work environment increases by 1.19 times [CI = 1.05-1.37] the odds of being part of the high R&D group; and
(5) PhD holders working in the university sector are 3.82 times more likely to be in the high R&D group (Wald $\chi2$ (1) = 75.93, p <.001; [CI = 2.83-5.17]), however the interaction between the sector and having children is significant (Wald $\chi2$ (1) = 14.91, p <.001. The odds ratio for PhD holders who work in the university sector indicate that[4] those who do not have children are 2.44 times more likely to be part of the high R&D group than those who have children. However, for PhD holders who work outside the university sector, those who do not have children are only 1.12 times more likely to be part of the high R&D group than those who have children. This odds ratio close to 1 illustrates that the fact of having children for PhD holders who work outside the university sector has a very little impact on their probability of belonging to the high R&D group.

Figure 6 illustrates the predicted probability by the regression model of being part of the high R&D group based on the interaction between the sectors of employment and having children. This probability was calculated individually for all PhD holders who were considered in the model, based on their individual profiles (gender, children, etc.). Although PhD holders who work in the university sector are more likely to be part of the high R&D group, this is less true for those with children. For example, according to this model, outside the university sector, the probability that PhD holders with children would be in the high R&D group is 39.3%, whereas for those without children this probability is 44.9%. On the other hand, in the university sector, the probability that those without children are in the high R&D group is 76.1%, whereas for PhD holders with children, this probability is 53.4%.

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[4] These estimations are based on an individual who is a man, in ENS, without mobility, who completed his PhD in 2018 (0 years since PhD completion), with an average score of 3.68 for the positive work environment.

Figure 6. Box plots depicting the predicted probability of time spent on R&D activities based on the interaction of the sector of employment and having children
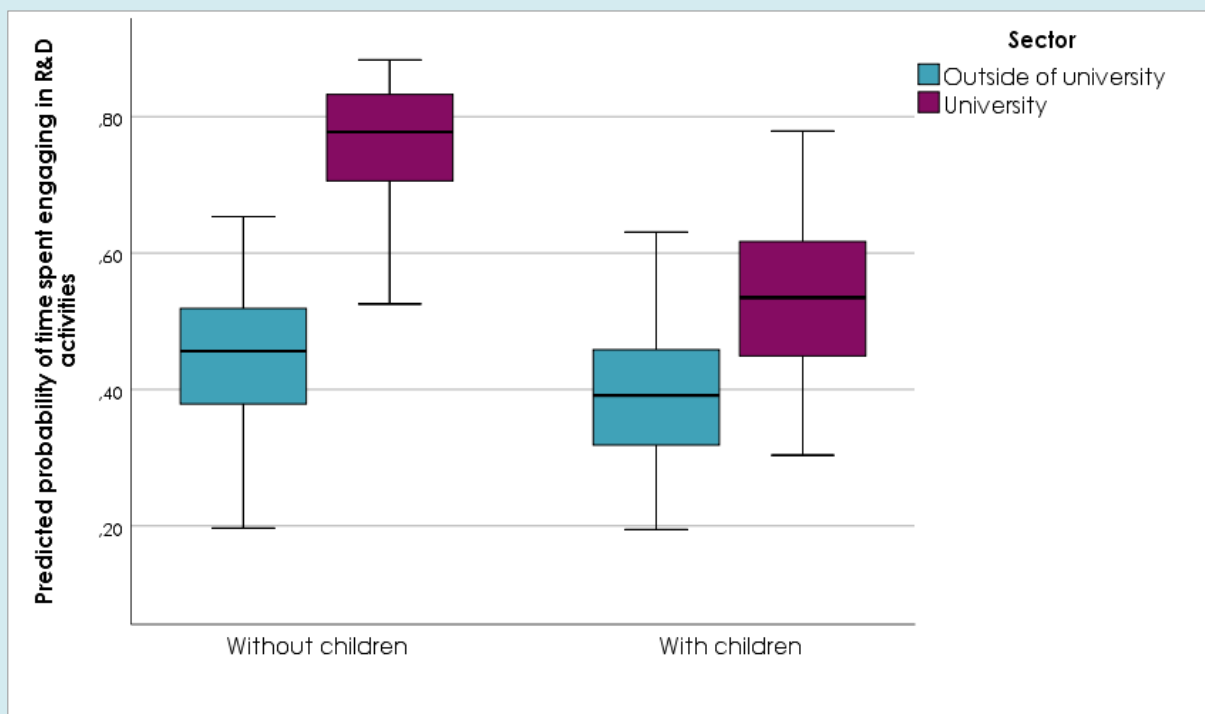
However, one must be cautious about the interpretation of these results: neither the causality nor the direction of the effects (that is to say unidirectional or bidirectional) can be deduced from these data. For example, it is likely that those who have been in mobility are more likely to seek a job with more R&D activities, but it is also likely that those who have been in mobility are more likely to be employed for positions that involve R&D.

3.2.   Relation of the position at the time of the survey to the research domain

In our sample, a very large proportion of PhD holders have positions that are related (59.1%) or somewhat related (27.2%) to their research domain (Figure 7).

*Figure 7. Is your current position related to your research domain? (n = 1,856)*
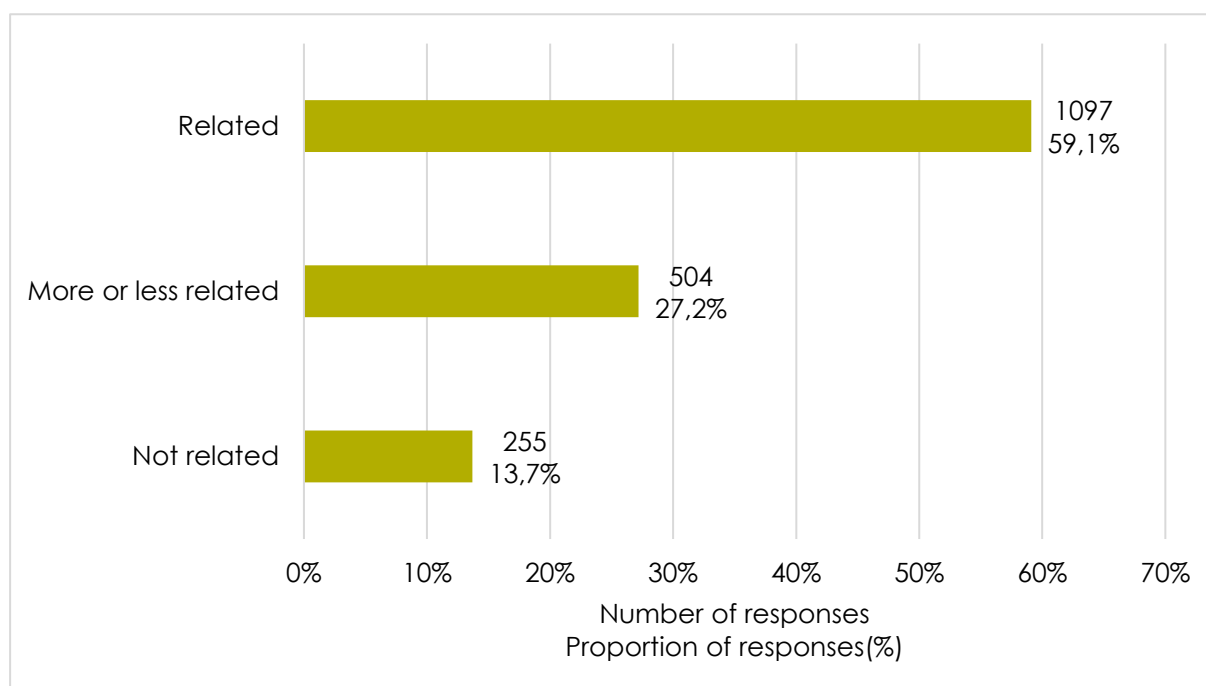
When we examine this relation by sector of employment, we realise that 23.5% of PhD holders working outside the university sector have positions that are not related to their research domain (Figure 8).

Figure 8. Relation between the position at the time of the survey and the research domain by sector of employment (n = 1,856)
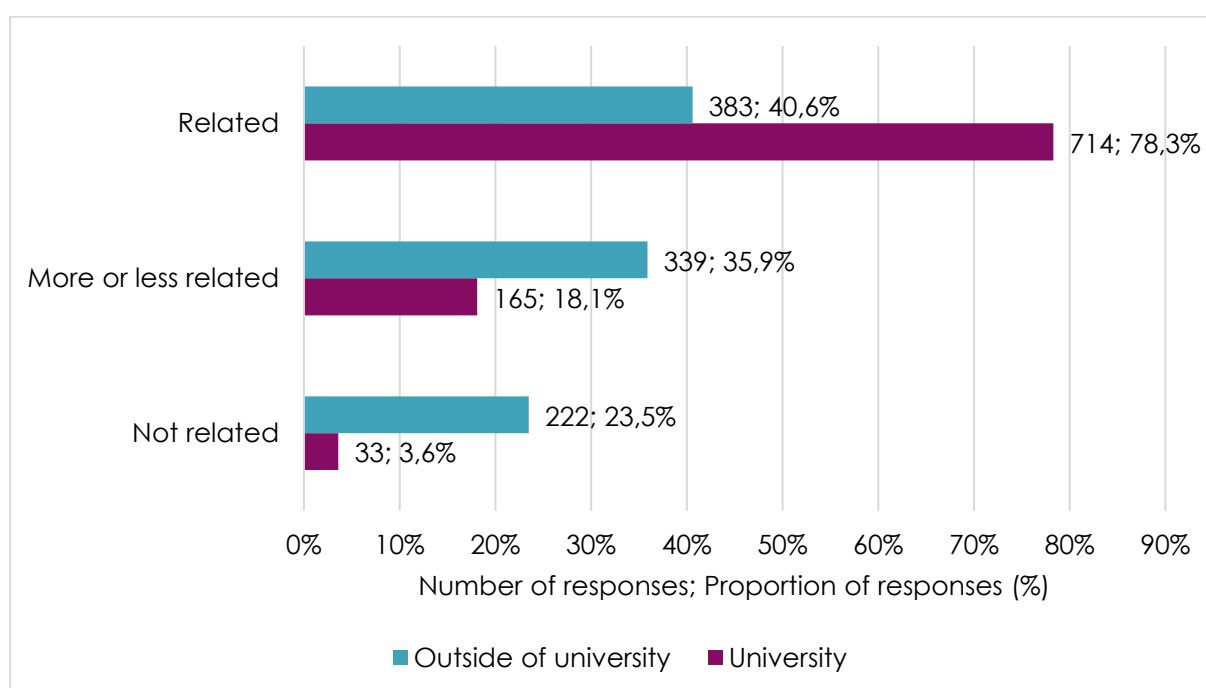
We asked those who held positions that were not related to their research domain (*n* = 255, 13.7% of the total sample: 9.5% of SSH, 14.9% of LHS and 16.0% of ENS) why they chose such a position. In line with the results on R&D activities, an important proportion (63.1%) stated that they could not find a position in their domain that was satisfying (Figure 9). Therefore, it would seem that when PhD holders hold positions outside their research domain, it is mostly owing to necessity rather than by personal choice.

Figure 9. Among the PhD holders who do not have a position "related" to their research domain, answers to the question: "Why did you choose to work outside your research domain?" (n = 255)
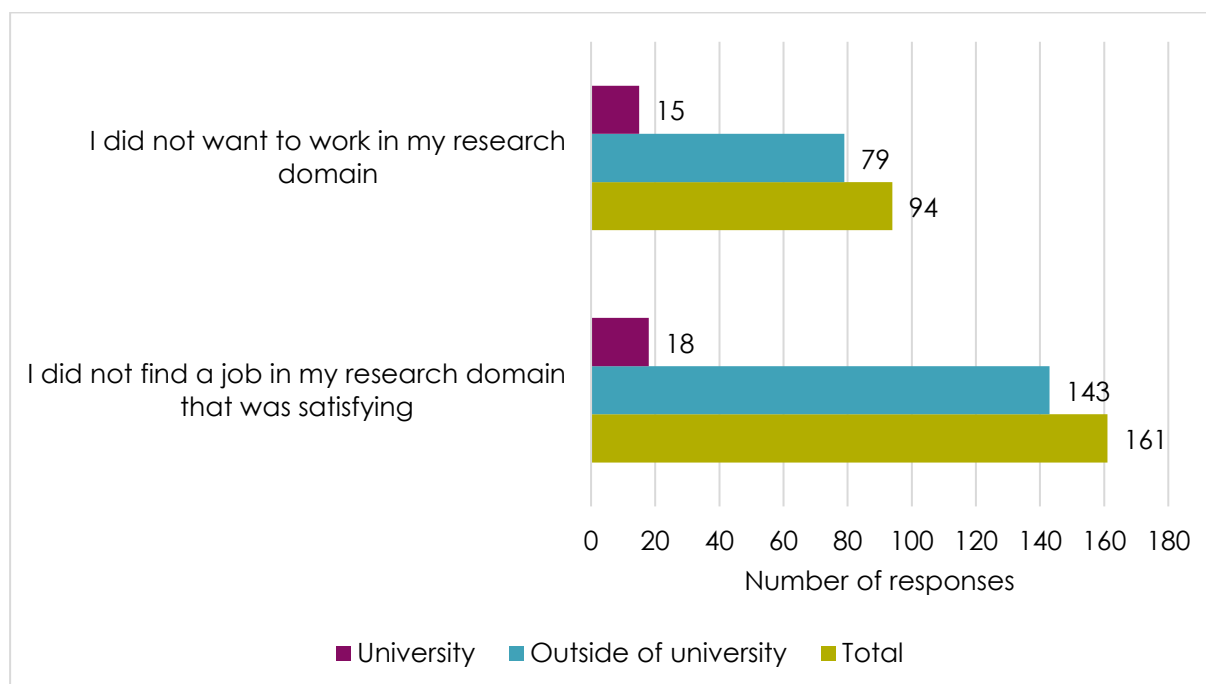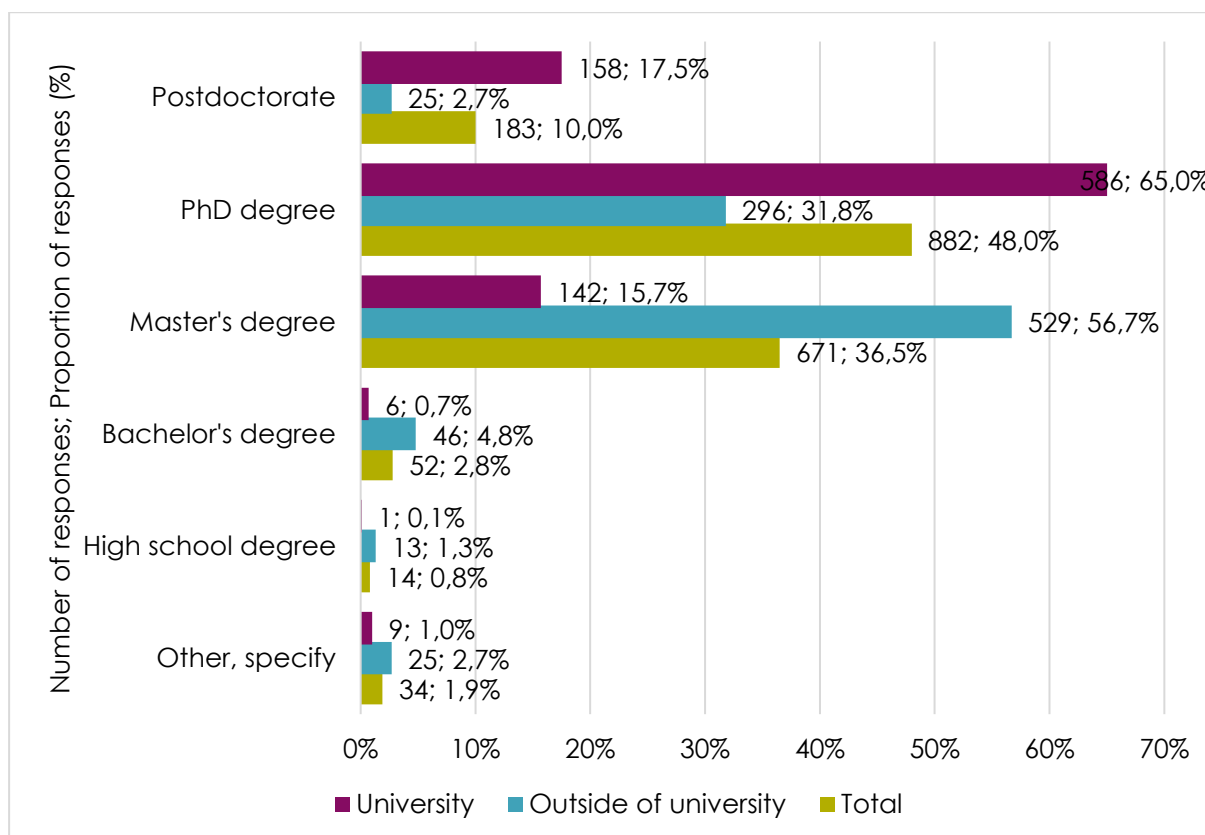

3.3.   Minimum level of qualification required

We asked PhD holders to indicate the minimum level of qualification required for the job they held at the time of the survey[5]. We see clear differences in the level of qualification required by sector of employment (Figure 10). 82.5% of PhD holders who work at universities have positions that require a PhD degree or a postdoctorate. However, this proportion significantly decreases when we consider sectors outside university: only 34.5% of PhD holders who work outside the university sector hold positions that require a PhD degree or a postdoctorate. It would seem that for a large majority of PhD holders, to work outside the university sector equates to accepting a job below their level of education.

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[5] 1,836 out of the 1,856 people solicited answered questions about the minimum qualification level required.

Figure 10. Minimum level of qualification required by sector of employment (n = 1,836)

When we look at the distribution of the minimum level of qualification required outside the university sector by research domain (Figure 11), we see that PhD holders in SSH have the highest rate of "overeducation[6]", with 78.1% holding positions that require a Master's degree or less. This proportion is 63.7% for ENS and 57.9% for LHS.

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[6] Overeducation describes the extent to which an individual has a higher level of education than is required for a particular job (McGuinness, 2006).

Figure 11. Minimum level of qualification required outside the university sector by research domain (n = 928)
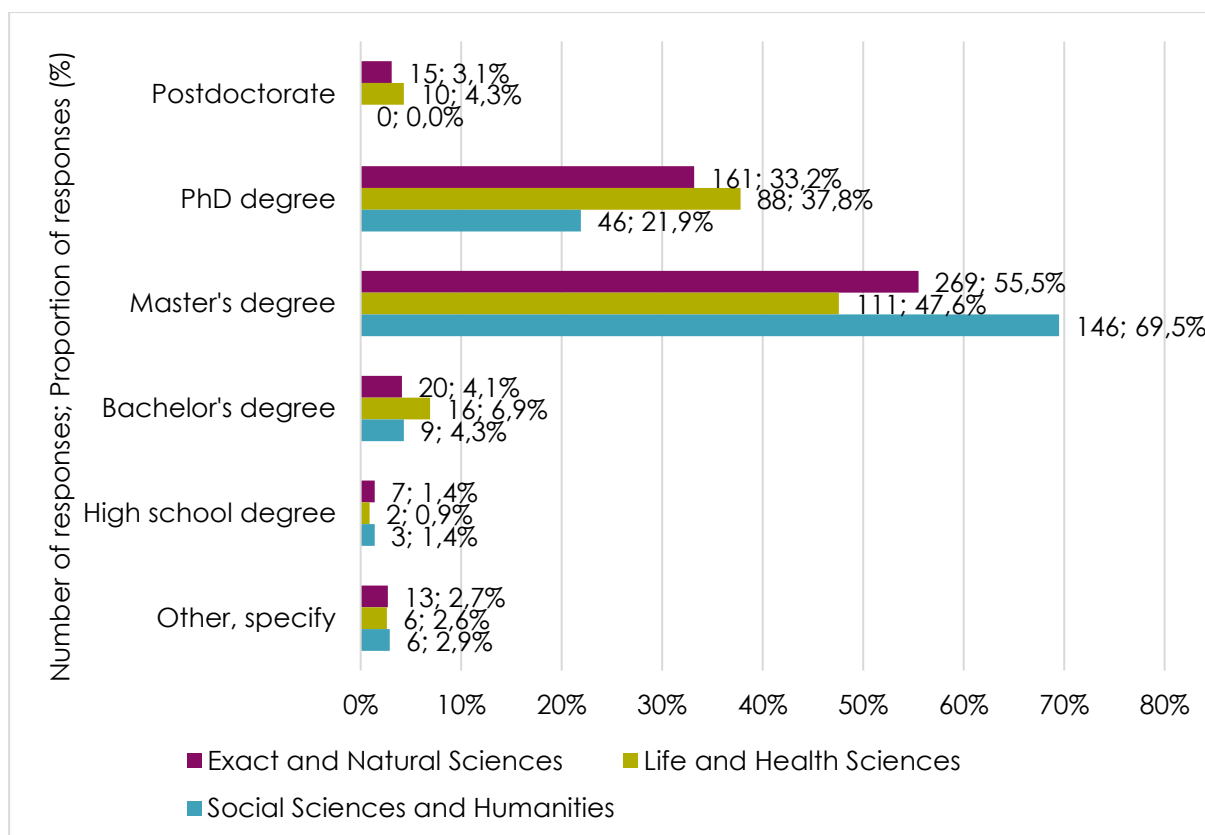
Outside the university sector the level of qualification required is relatively evenly distributed by gender (Figure 12).

Figure 12. Minimum level of qualification required outside the university sector by gender (n = 924)
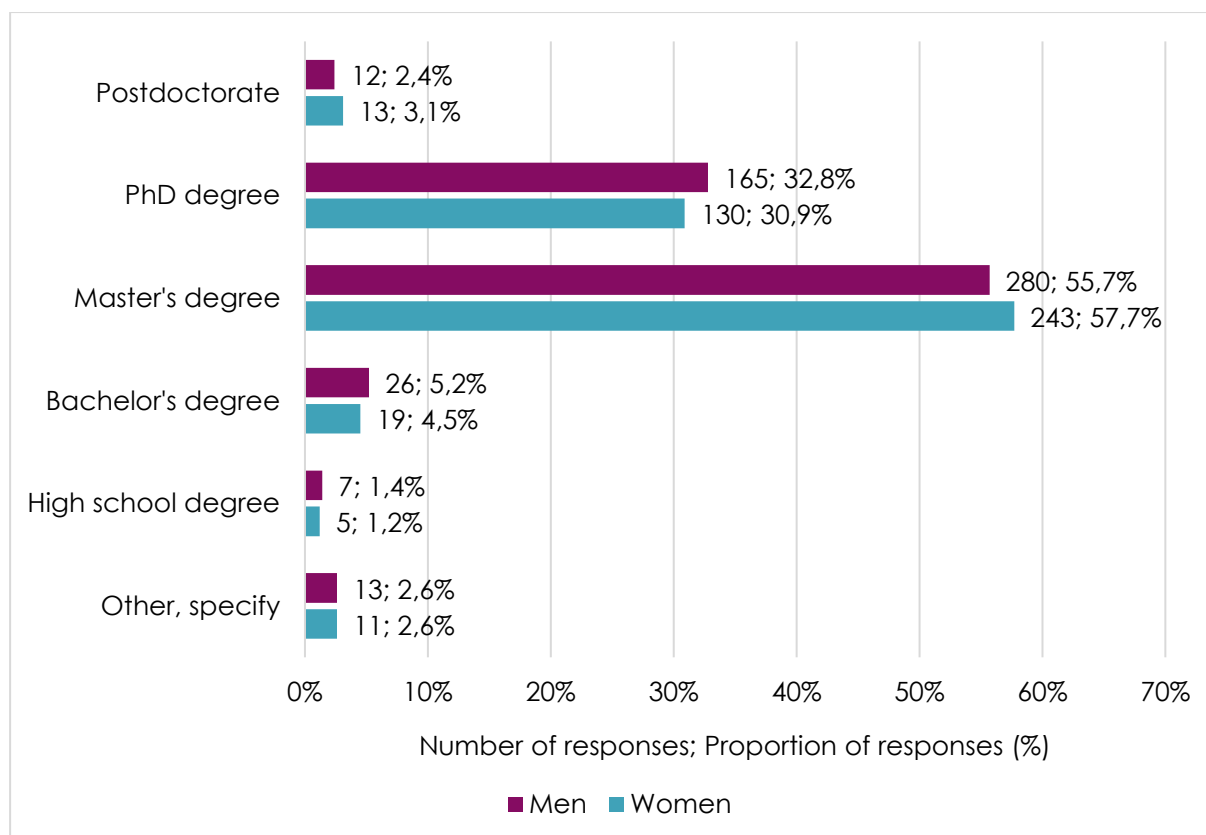
3.4. Level of salary

We asked PhD holders to indicate the range of their net monthly salary. Looking at those who were employed or self-employed full-time (*n* = 1,605)[7] in our sample, we can see that a very large majority of PhD holders (75.1%) who work in Belgium earn between €2,001 and €3,000 net per month. 14.5% report earning over €3,000 net per month and 8.2% report salaries of less than €2,000 net (Figure 13).

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[7] 1,605 out of the 1,672 people working full-time answered the questions about income, and 1,582 of those 1,605 people responded to the mobility questions at the end of the questionnaire.

Figure 13. Net monthly salary of PhD holders working full-time in and outside of Belgium (n = 1,582)
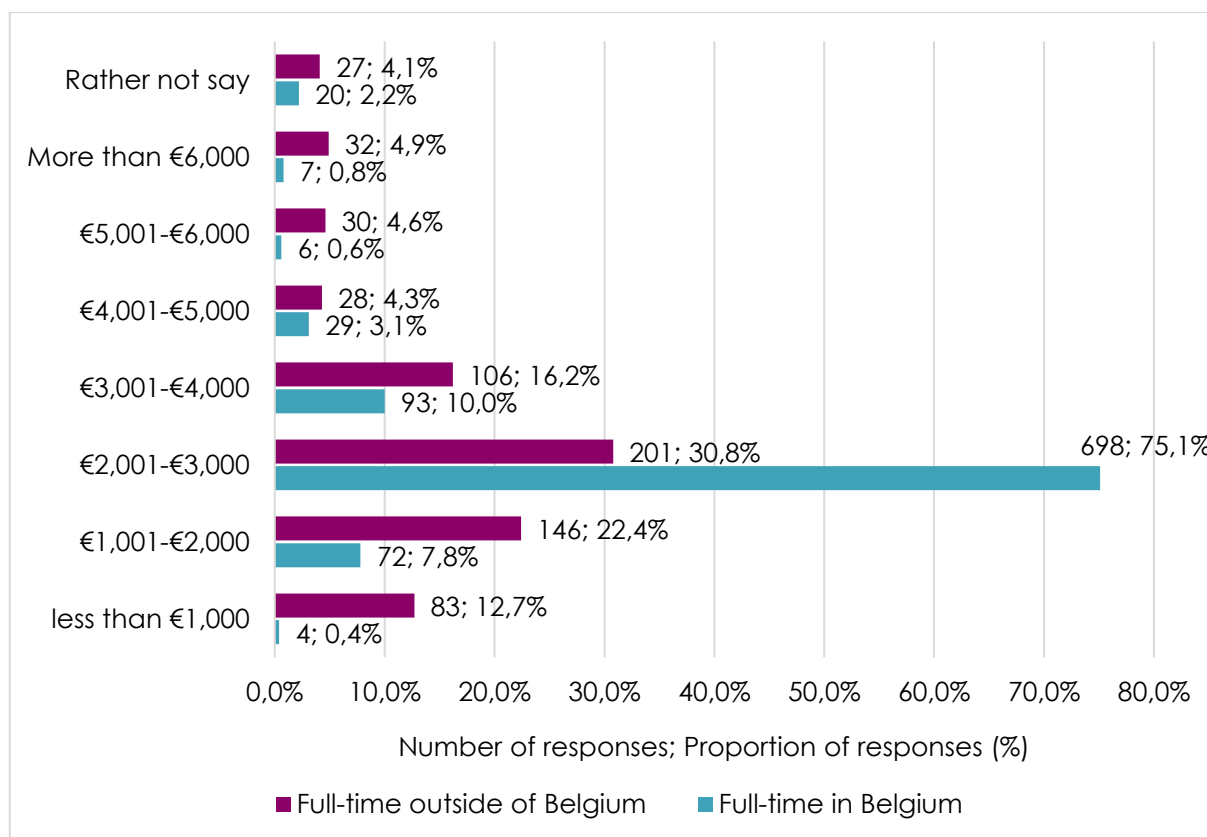
When we specifically look at how gender (Figure 14)and the years since doctoral completion (3 years or more = 1; less than 3 years = 0) are related to the level of net monthly salary of full-time employees in Belgium, the results of ordinary logistic regressions indicate that, controlling for other factors, women have lesser odds of being in the higher salary categories than men [OR = .56 ; 95% CI = .41 to .77], a statistically significant effect, Wald $\chi 2$ (1) = 12,55, p < ,001(please refer to the Appendix for details). For instance, the estimated probability of a man having a salary below the median (€2.001-€3.000) is 7% whereas for women that probability is 11%. Similarly, the estimated probability of a man having a salary above the median is 17% whereas for women that probability is 10%. In addition, PhD holders who have completed their doctorate 3 years ago or more are 2.65 times more likely to be in the higher salary categories [95% CI = 1.89 to 3.73], Wald $\chi 2$ (1) = 31.61, p < .001, compared to those who completed less than 3 years ago. The level of net monthly salary of full-time employees in Belgium based on research domain is displayed in Figure 15[8].

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[8] An examination of the fit indices of an ordinary logistic model that included research domains indicated the rejection of the proportional odds assumption for the model, the test of parallel lines being significant. Thus this model was not retained.

Figure 14. Net monthly salary of PhD holders working full-time in Belgium by gender
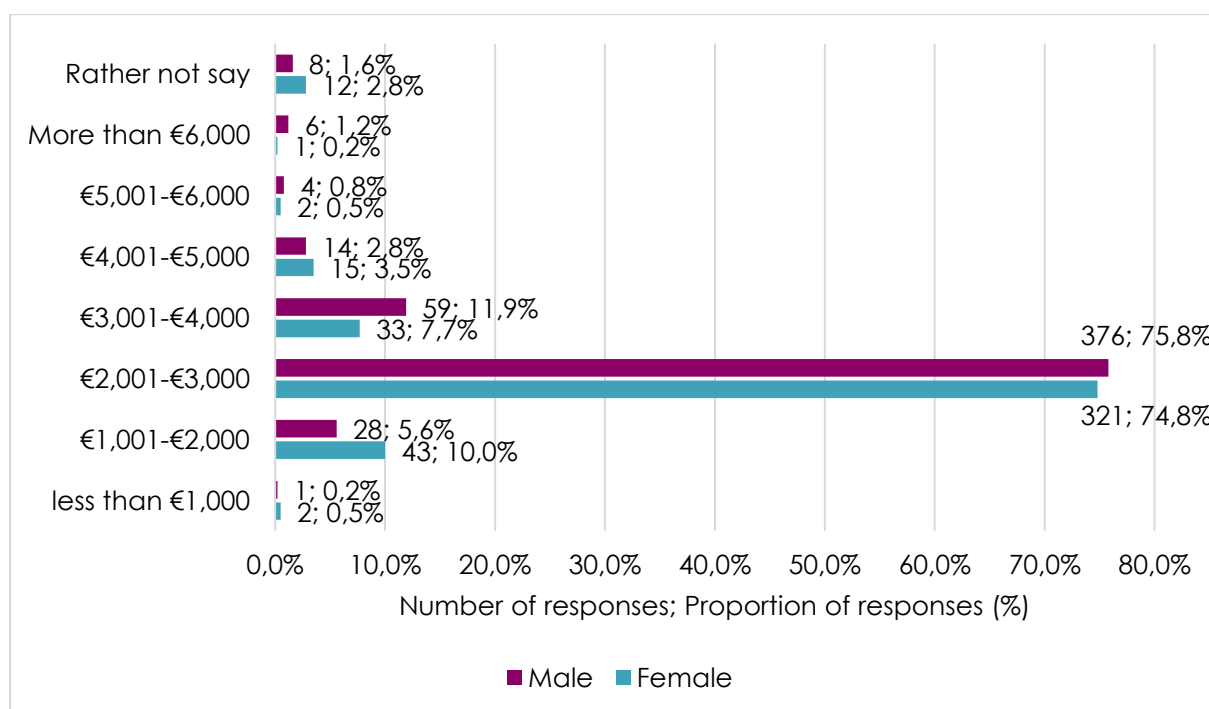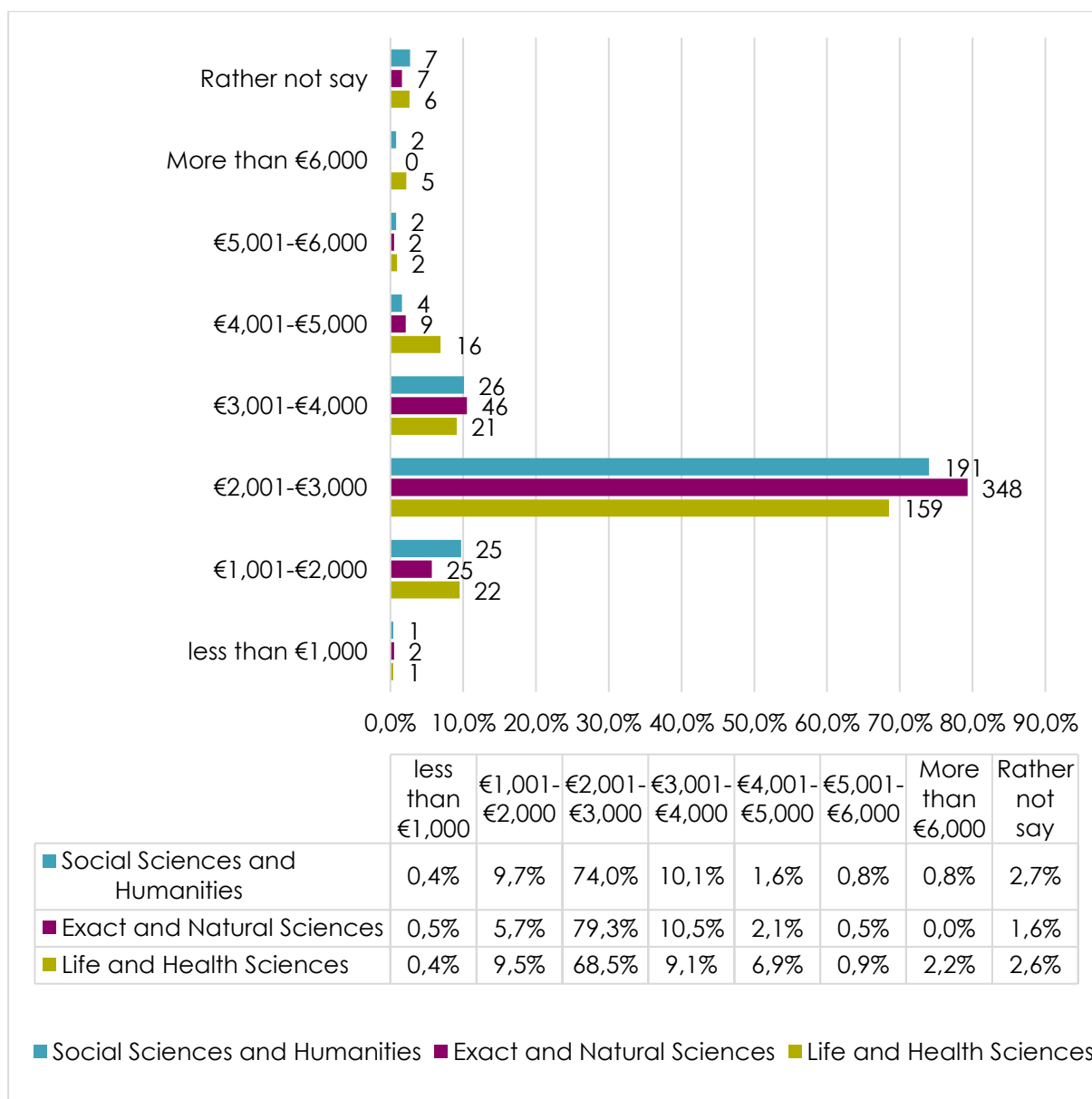
Figure 15. Net monthly salary of PhD holders working full-time in Belgium by research domain

	less than €1,000	€1,001-€2,000	€2,001-€3,000	€3,001-€4,000	€4,001-€5,000	€5,001-€6,000	More than €6,000	Rather not say
■ Social Sciences and Humanities	0,4%	9,7%	74,0%	10,1%	1,6%	0,8%	0,8%	2,7%
■ Exact and Natural Sciences	0,5%	5,7%	79,3%	10,5%	2,1%	0,5%	0,0%	1,6%
■ Life and Health Sciences	0,4%	9,5%	68,5%	9,1%	6,9%	0,9%	2,2%	2,6%

■ Social Sciences and Humanities   ■ Exact and Natural Sciences   ■ Life and Health Sciences

3.5. Skills

In order to measure the match between the skills acquired before and during the doctoral training and those used in the workplace, we asked PhD holders to rank from 1= "not at all" to 5 = "very much" to what extent they acquired a list of skills ranging from "research skills" to "business skills"[9]. The skills used in this list came either from international studies on PhD holders (European Science Foundation, 2017 ; OECD, Mapping Careers and Mobility of Doctorate Holders, Auriol, Schaaper, & Felix, 2012) or from studies on employers targeting skills considered

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[9] In the questionnaire, we did not provide a definition of the skills listed.

as important in the workplace (De Grande, 2009 ; De Grande, De Boyser, Vandevelde, & Van Rossem, 2011, 2014). These skills reflect five major categories of skills:

- Research skills and technical expertise (four items: "scientific and technical expertise", "research skills", "critical and analytical thinking", and "problem-solving skills")
- General management skills (two items: "business skills" and "project management")
- Working with others (two items: "collaboration and team work" and "social skills and intercultural competency")
- Communication skills (one item: "communication")
- Personal effectiveness (three items: "initiative and autonomy", "flexibility and adaptability", and "creativity and innovation")

Then we asked the participants who stated that they had a job at the time of the survey if they were using these skills in the workplace[10].

3.5.1. Acquired skills

The three skills that were ranked as acquired (4 or 5) by most PhD holders are "critical and analytical thinking" (92.4%), "research skills" (91.4%), and "scientific and technical expertise" (90.3%). On the other hand, three skills that were ranked as not acquired (1) or partially acquired (2 or 3) are "business skills" (77.5%), "collaboration and team work" (26.7%), and "social skills and multicultural competency" (22.4%) (Figure 16)[11].

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[10] It should be noted that our goal was not to assess the added skills acquired during doctoral degrees compared to those acquired during undergraduate or Master's degrees.
[11] 1,966 out of the 2,055 people solicited answered the questions about skills, which were at the end of the questionnaire.

Figure 16. To what extent did you acquire the following skills during your PhD? (n = 1,966; 1 = not all to 5 = very much)
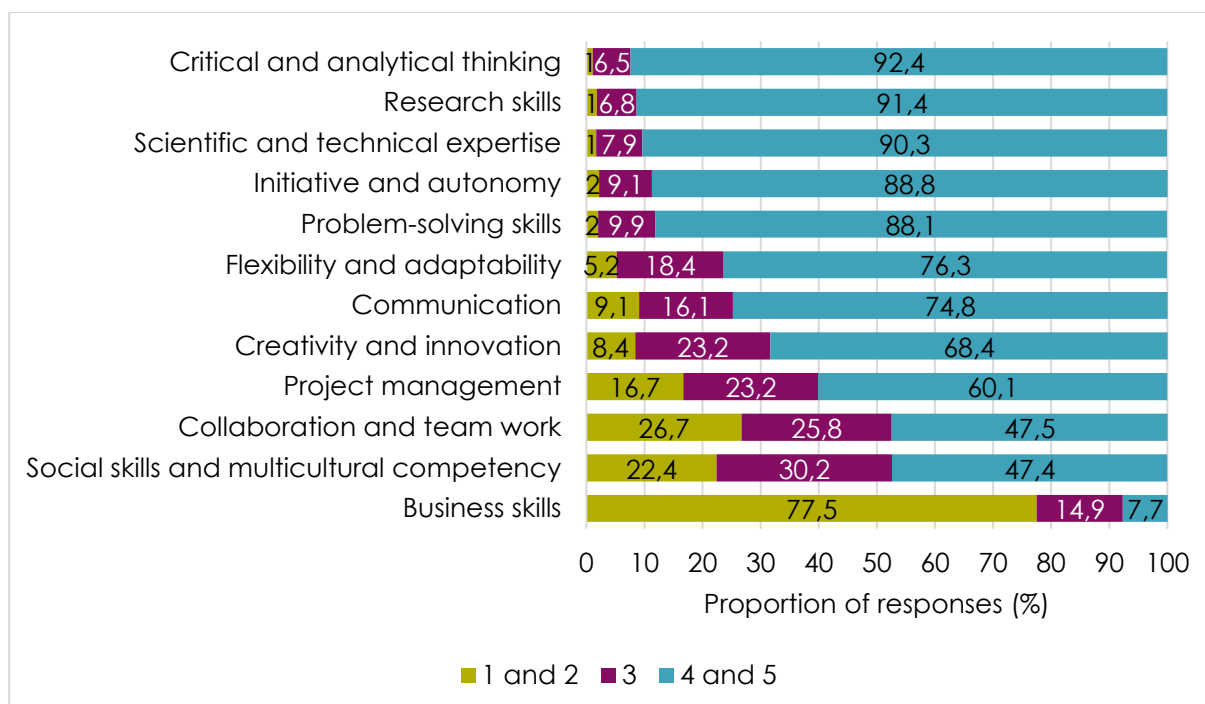
3.5.2. Used skills

The three skills that PhD holders said they used most in the workplace are "initiative and autonomy" (95.6%), "communication" (95.6%) and "critical and analytical thinking" (95.3%) (Figure 17).

Figure 17. Are you using these skills in your current job? (n = 1,836)
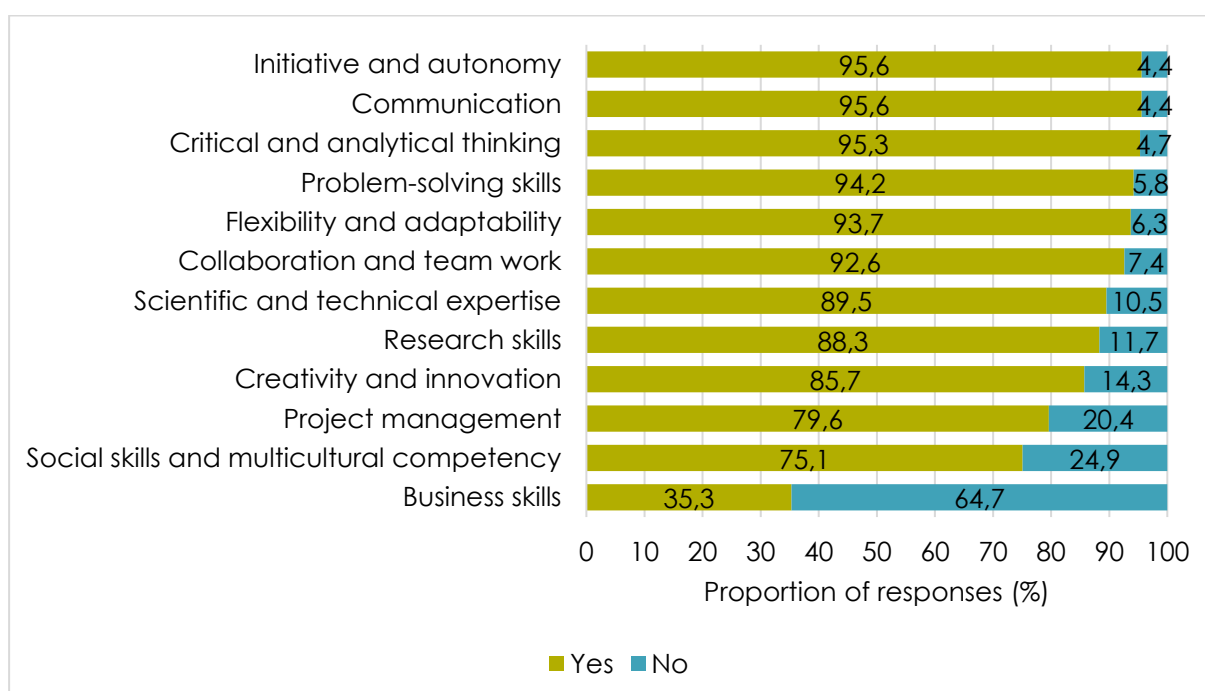
3.5.3. Match between acquired and used skills

When we look at the difference between the proportion of respondents who acquired a certain skill and those who use that skill (Figure 18), we realise that the biggest gap concerns "collaboration and team work". Only 47.5% of PhD holders say they acquired this skill but 92.6% use it in the workplace. The three other skills with the highest difference are "social skills and multicultural competency", "business skills", and "communication". With regards to the match between acquired and used skills by research domain, there are very few differences (see the Appendix for additional figures).

Figure 18. Proportion of PhD holders who reported having acquired a skill at the end of the doctorate (n = 1,966) and using it as part of their job (n = 1,836)

> Skills not acquired but used

We then paid particular attention to the skills PhD holders reported not to have acquired by the end of their doctoral training in order to identify whether and to what extent these skills were being used in the workplace. When we divide the sample by sector of employment, we see that for PhD holders working outside the university sector (*n* = 1,143), there are three important not acquired (or only partially acquired) skills used in the workplace (Figure 19). By order of importance, these skills are "collaboration and team work", "business ski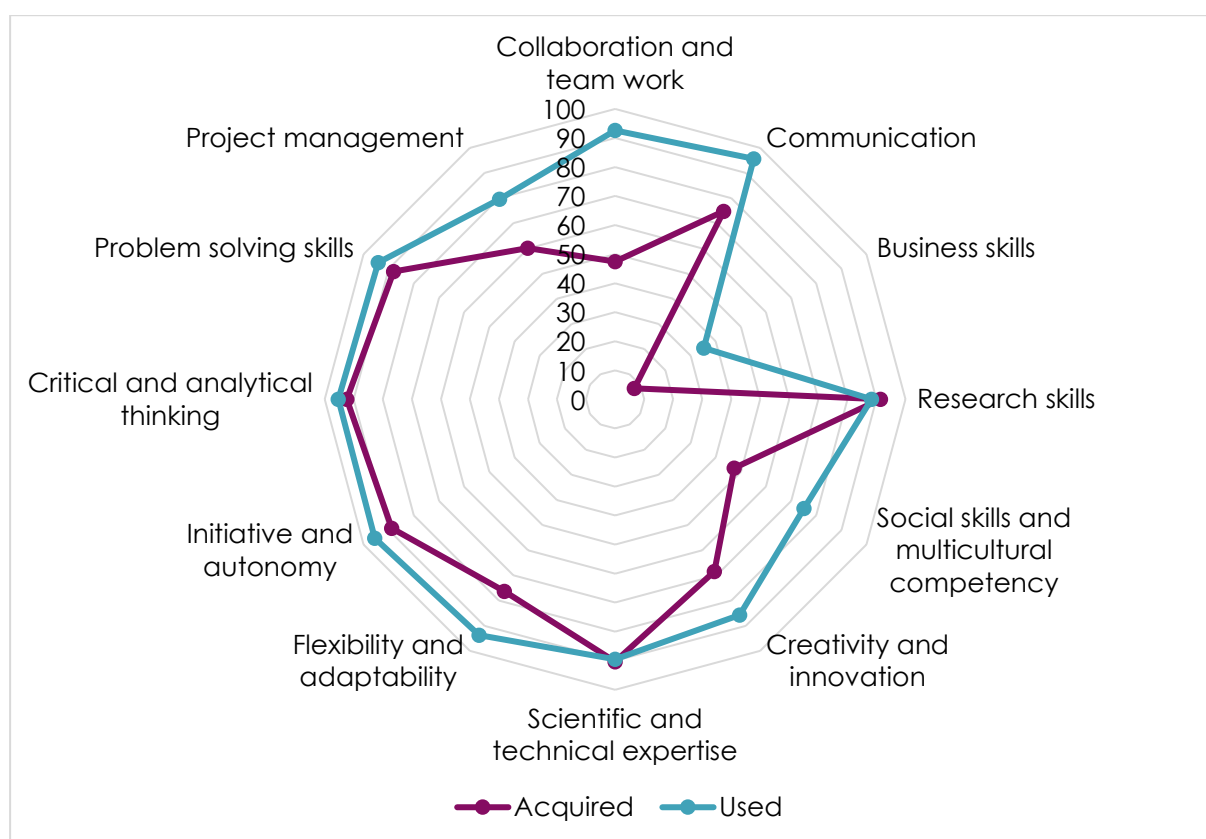lls" and "social skills and multicultural competency". For instance, out of 524 PhD holders who said they did not acquire collaboration and team work, 483 (92.1%) reported using it in the workplace.

Figure 19. Number of PhD holders who indicated that they had not acquired or had only partially acquired a skill by the end of their doctorate (mauve), and of those, the number of them using it as part of their job (blue) outside the university sector (n = 1,143)
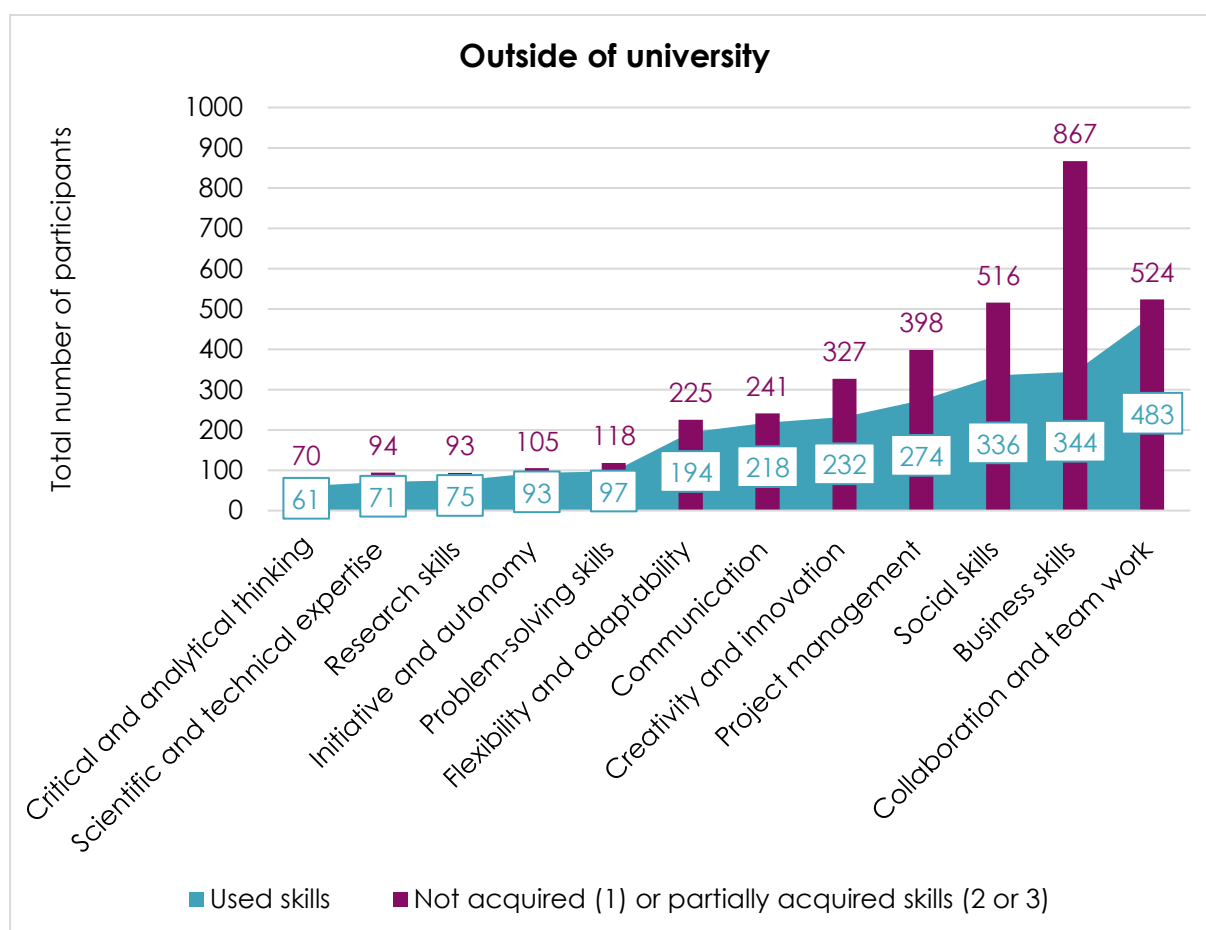
For those working in the university sector (*n* = 912), the three skills not acquired (or only partially acquired) by the end of the doctoral training but used in the workplace are "collaboration and team work", "social skills and multicultural competency", and "project management" (Figure 20). For instance, out of 468 PhD holders who said they did not acquire or only partially acquired "social skills and multicultural competency", 289 (61.8%) reported using it in the workplace.
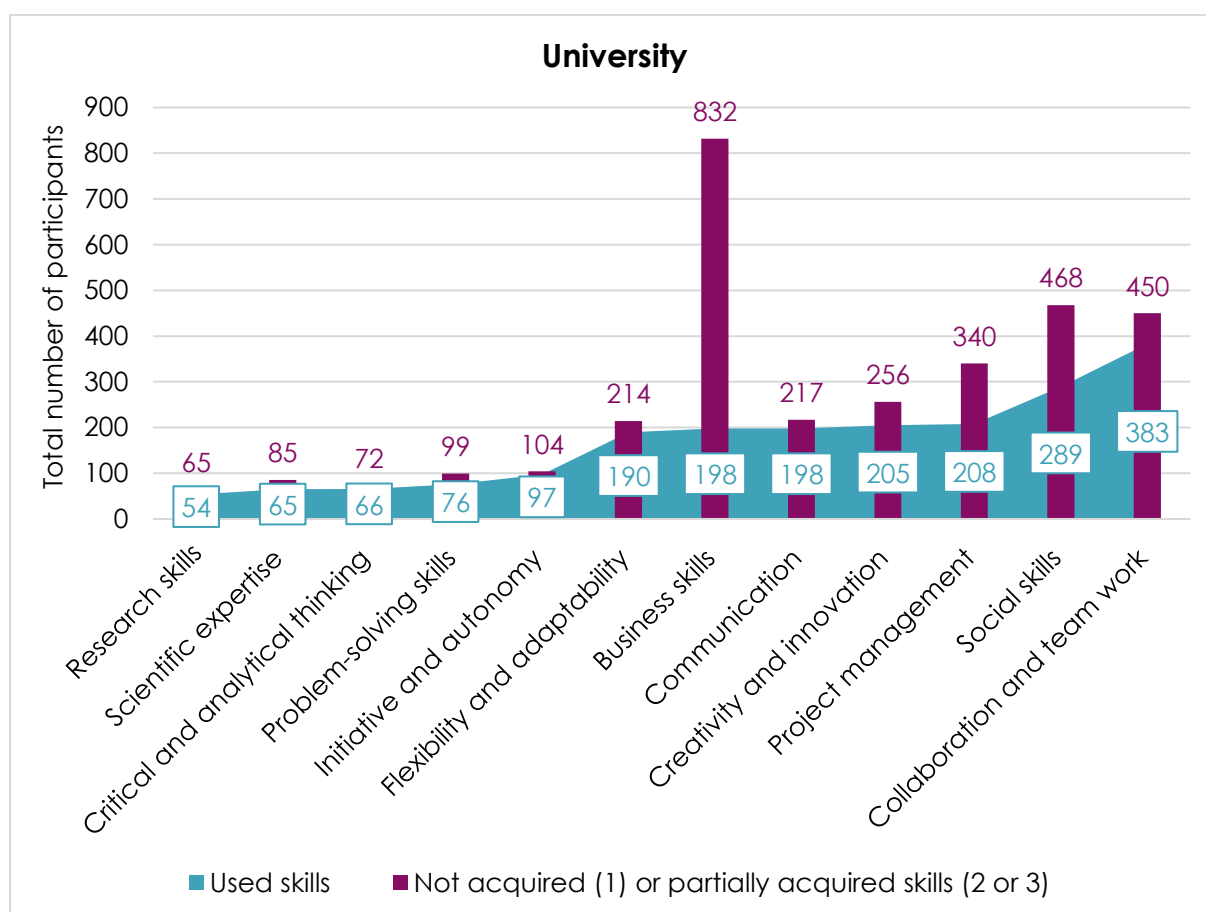
Figure 20. Number of PhD holders who indicated that they had not acquired or had only partially acquired a skill by the end of their doctorate (mauve), and of those, the number using it as part of their job (blue) within the university sector (n = 912)

We can therefore observe a mismatch between the skills PhD holders reported to have acquired and the skills they reported to have to use in the workplace, regardless of their sector of employment. This discrepancy concerns above all, "**collaboration and team work**", "**social skills and multicultural competency**" and "**project management**". In addition, our results point to the need for business-skills training, especially for PhD holders who will later work outside the university sector.

> Skills acquired but not used

The existence of skills acquired but not used by PhD holders raises the question of the return on investment in terms of human capital, since it indicates that PhD holders do not use all the skills acquired in the course of their training. Low percentages in Figure 21 and Figure 22 indicate that most PhD holders, independent of their sector of employment, use almost all the skills they acquired in the course of their training in the workplace. Only 17.2% of PhD holders who work outside the university sector report not using their "research skills", and only 13.6% their "scientific and technical expertise". Therefore, it would seem that once the professional skills are acquired, PhD holders find ways to apply their skills in their work environment.

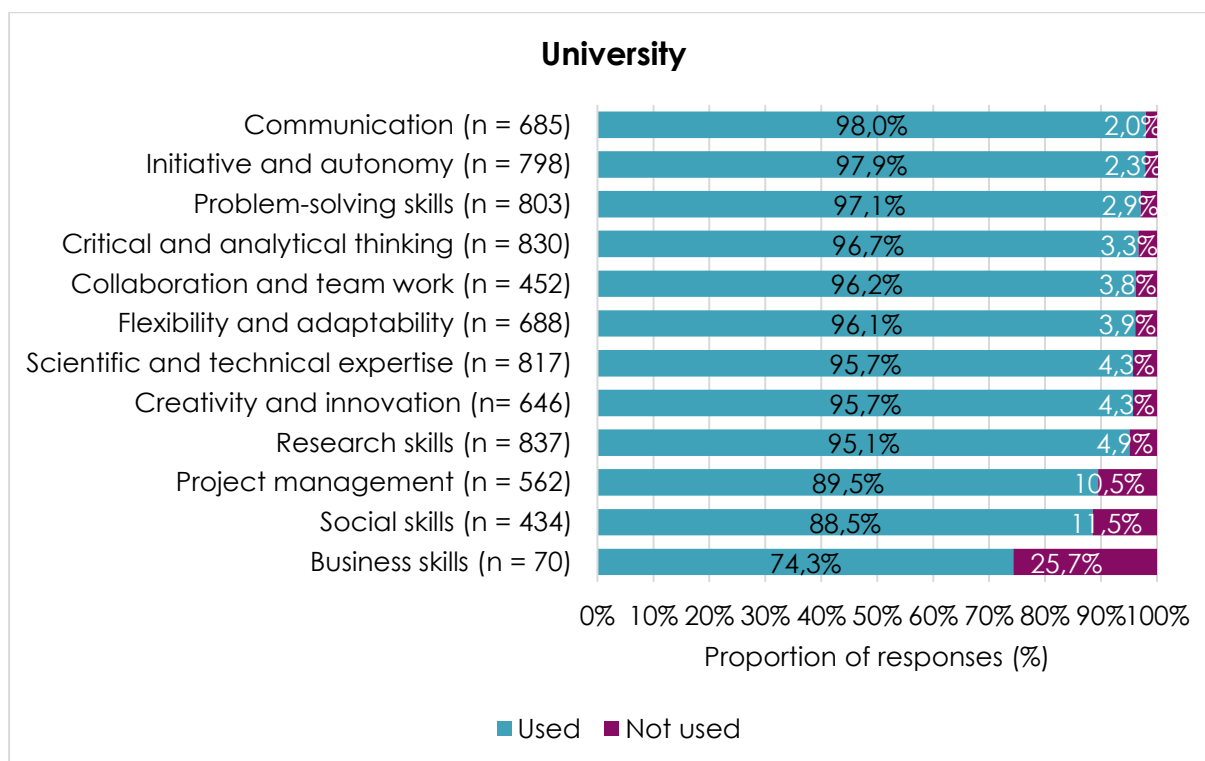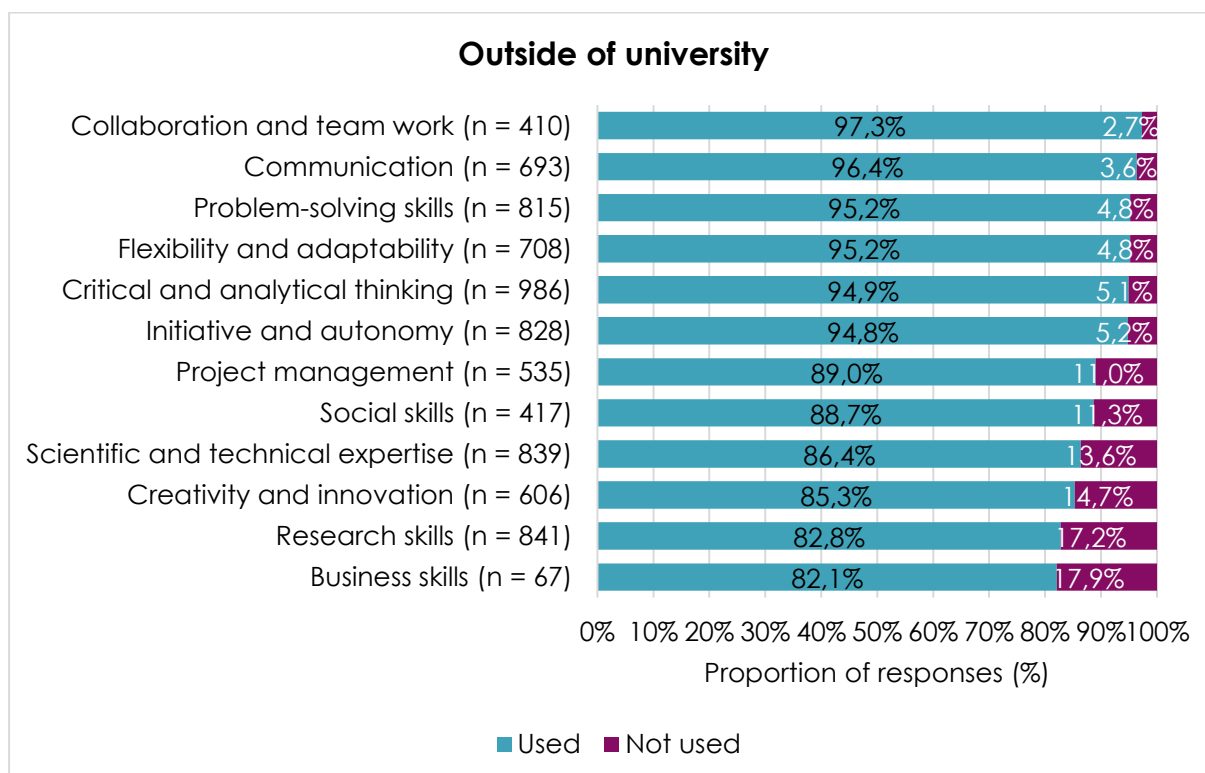*Figure 21. Skills acquired, categorised by their use by PhD holders working in the university sector*

University

Skill	Used	Not used
Communication (n = 685)	98,0%	2,0%
Initiative and autonomy (n = 798)	97,9%	2,3%
Problem-solving skills (n = 803)	97,1%	2,9%
Critical and analytical thinking (n = 830)	96,7%	3,3%
Collaboration and team work (n = 452)	96,2%	3,8%
Flexibility and adaptability (n = 688)	96,1%	3,9%
Scientific and technical expertise (n = 817)	95,7%	4,3%
Creativity and innovation (n= 646)	95,7%	4,3%
Research skills (n = 837)	95,1%	4,9%
Project management (n = 562)	89,5%	10,5%
Social skills (n = 434)	88,5%	11,5%
Business skills (n = 70)	74,3%	25,7%

0% 10% 20% 30% 40% 50% 60% 70% 80% 90%100%
Proportion of responses (%)

■Used ■Not used

Figure 22. Skills acquired categorised by their use by PhD holders working outside the university sector

Outside of university

Skill	Used	Not used
Collaboration and team work (n = 410)	97,3%	2,7%
Communication (n = 693)	96,4%	3,6%
Problem-solving skills (n = 815)	95,2%	4,8%
Flexibility and adaptability (n = 708)	95,2%	4,8%
Critical and analytical thinking (n = 986)	94,9%	5,1%
Initiative and autonomy (n = 828)	94,8%	5,2%
Project management (n = 535)	89,0%	11,0%
Social skills (n = 417)	88,7%	11,3%
Scientific and technical expertise (n = 839)	86,4%	13,6%
Creativity and innovation (n = 606)	85,3%	14,7%
Research skills (n = 841)	82,8%	17,2%
Business skills (n = 67)	82,1%	17,9%

0% 10% 20% 30% 40% 50% 60% 70% 80% 90%100%
Proportion of responses (%)

■Used ■Not used

4. CONCLUSIONS

The main goal of this report was to analyse the education-job match of PhD holders at the time of the survey. This analysis has produced encouraging results regarding the match between the training PhD holders received and their work, but also points to some challenges they face.

The findings suggest that the majority of PhD holders spend at least 30% of their time in the workplace on R&D activities and have positions that are related or more or less related to their research domain. Importantly, independent of their sector of employment, it would seem that the skills they have acquired before and during their doctoral training are being transferred to their work environment. However, the results also indicate that the majority of PhD holders working outside the university sector hold positions that require a Master's degree or less. We can also observe a discrepancy between the skills PhD holders have acquired and those which they have to use in the workplace, in particular with regard to "general management skills" and "working with others". In addition, factors such as gender and having children seem to play a role. For instance, compared to men, women are less likely to earn more than €3,000 net per month. Moreover, PhD holders working in the university sector who have children spend less time on R&D activities than PhD holders without children.

Despite the differences observed among the major domains of research, combined with the results of our first report, the results of this report suggest that if PhD holders decide to stay in academia, the majority continues to work under temporary contracts at least in the first few years following their doctoral completion. If they decide to leave academia, their job does not systematically require a PhD.

The question remains - could a job that does not require a PhD nevertheless be satisfying for PhD holders? The answer is yes, if certain conditions are met. This will be the focus of the Observatory's third report, which will be based on the "Future of PhD Holders" survey.

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6. APPENDIX

The objective of this section is to detail the statistical analyses we ran to model the time spent on R&D activities and the level of salary of PhD holders. In order to determine the probability of engaging in R&D, we used logistic regressions. In order to predict the level of salary of PhD holders, we used ordinal logistic regressions.

6.1. Logistic regressions

In a typical logistic regression, there is one dichotomous dependent variable, coded traditionally as 1 for the event occurring and 0 for the event not occurring. For instance, those who were identified as high R&D group were coded as 1, and those who were in the low R&D group were coded as 0. The objective of this analysis is to determine the probability that a case will belong to the event category.

In a typical ordinal logistic regression, the dependent variable is ordinal, with a clear ordering. For example, a Likert-scale from 1 to 4 (very dissatisfied, dissatisfied, satisfied, or highly satisfied), or a variable like the level of salary, with three categories (low, medium and high) could be considered as ordinal variables. The objective of this analysis is to determine the probability that a case will belong to each level.

Just as in linear regressions, we can include multiple predictor variables in our model. Statistical measures that are reported include:

a. Odds ratio. The odds ratio (OR) is a statistical measure that compares whether the probability of an event occurring is the same for two groups. An odds ratio of 1 implies that the event is equally likely for both groups. Odds ratios greater than 1 suggest that PhD holders in a particular group (e.g., those with children) are more likely to be in the event category (e.g., have a permanent contract) compared to the other group (e.g., those without children). Odds ratios less than 1 suggest that PhD holders in a particular group are less likely to be in the event category compared to the other group. The confidence interval (CI) indicates 95% confidence interval for the OR.

b. Evaluation of the logistic model. Logistic regression produces a number of tests to assess the validity of the model:

- *Omnibus test of model coefficients:* This chi-square test evaluates whether the set of predictor variables improves the prediction of the dependent variable over the constant only model, which has no predictors.
- *Cox and Snell and the Nagelkerke Pseudo R^2*: They determine the goodness of fit of the model.
- *Wald test:* This test measures the statistical significance of the unique contribution of each coefficient in the model.

6.2. Time spent on research and development activities

The amount of time spent on R&D activities was calculated based on the median percentage of time. We coded those who spent 50% or more of their time on R&D as the high R&D group (coded as 1) and lower than 50% of their time as the low R&D group (coded as 0).

In order to determine the probability of being in the high R&D group, we included gender (female = 1), research domain (SSH, LHS: ENS as the reference group), having children (yes = 1), mobility (yes = 1), years since PhD, positive work environment (M = 3.68, SD = .76), sector (university = 1 and other sectors = 0). We adjusted a model that includes the interactions between sector and having children, mobility and having children, gender and having children, positive work environment and having children as well as the interactions between sector and gender, mobility and gender and positive work environment and gender.

Through a forward selection logistic regression model, we identified the significant variables predicting the probability of being in the high R&D group. Results indicated that the model provided a statistically significant improvement over the constant only model, χ^2 (9) = 224.82, p<.001 (Hosmer-Lemeshow: χ^2 (8) = 12.83, p = .12). The goodness of fit as indicated by Nagelkerke pseudo R^2 was .15 (Cox and Snell = .11). The assumptions of this model (the normality of residuals, homoscedasticity, etc.) have been validated.

Table 1. Logistic regression analysis on the likelihood of PhD holders engaging in high levels of R&D activity

	B	S.E.	Wald	df	p-value	Exp(B)	95% C.I.for EXP(B)	
							Lower	Upper
Gender	,030	,106	,081	1	,775	1,031	,838	1,267
SSH vs ENS	-,552	,124	19,783	1	,000	,576	,452	,735
LHS vs ENS	-,326	,129	6,347	1	,012	,722	,561	,930
Children	-,115	,138	,700	1	,403	,891	,680	1,168
Mobility	,527	,103	26,375	1	,000	1,694	1,385	2,071
Years since PhD	-,071	,027	6,961	1	,008	,932	,884	,982
Positive work environment	,178	,068	6,814	1	,009	1,194	1,045	1,365
University vs Outside of university	1,341	,154	75,926	1	,000	3,821	2,827	5,166
University*Children	-,779	,202	14,907	1	,000	,459	,309	,681
Constant	-.712	,294	5,862	1	,015	,490		

The significant variables are in bold.

6.2.1. Adjusted logistic regression model

$$\text{logit } \pi(x) = -.712 + .030 * \begin{cases} 1 \text{ if gender} = \text{ women} \\ 0 \text{ if gender} = \text{ men} \end{cases} - .552 * \begin{cases} 1 & \text{if domain} = \text{ SSH} \\ 0 & \text{otherwise} \end{cases} - .326$$

$$* \begin{cases} 1 & \text{if domain} = \text{ LHS} \\ 0 & \text{otherwise} \end{cases} - .115 * \begin{cases} 1 & \text{if children} \\ 0 & \text{if without children} \end{cases} + .527 * \begin{cases} 1 & \text{if mobility} \\ 0 & \text{if without mobility} \end{cases}$$

$$- .071 * \text{years since PhD} + .178 * \text{positive work environment} + 1.341 * \begin{cases} 1 & \text{if university} \\ 0 & \text{otherwise} \end{cases}$$

$$- .779 * \begin{cases} 1 & \text{if university} \\ 0 & \text{otherwise} \end{cases} * \begin{cases} 1 & \text{if with children} \\ 0 & \text{if without children} \end{cases}$$

6.2.2. Odds and odds ratio

According to these estimations, if the individual is a man, in ENS, without mobility, who obtained his doctorate in 2018 (0 years since doctoral completion), and with an average score of 3.68 on positive work environment, we have the following odds:

> For men with **children** who work in the **university sector**:
$\pi(x)/1 - \pi(x) = \exp(-.712 + 1.341 - 0.115 - 0.779 + 0.178 * 3.68) = 1.48$
> For men **without children** who work in the **university sector :**
$\pi(x)/1 - \pi(x) = \exp(-.712 + 1.341 + 3.68 * 0.178) = 3.61$

The odds ratio for those who work in the university sector calculated by using the variable "children" (Odds of not having children/Odds of having children) is therefore 3.61/1.48 = 2.44.

And we have the following odds:

> For men who have **children** who work **outside the university sector**,:
$\pi(x)/1 - \pi(x) = \exp(-.712 - 0.115 + 3.68 * 0.178) = 0.84$
> For men **without children** who work **outside the university sector**:
$\pi(x)/1 - \pi(x) = \exp(-.712 + 0.178 * 3.68) = 0.94$

The odds ratio for those who work outside the university sector calculated by using the variable "children" (Odds of not having children/Odds of having children) is therefore 0.94/0.84 = 1.12.

6.3. Level of salary

For the following model, we predicted the level of salary of PhD holders working full-time in Belgium. In order to estimate our model, we used a cumulative logit, which uses the function $a_i - Xb$. The predicted cumulative probabilities were accumulated by using the "bottom-up" approach. In this approach, each threshold is used to construct a model for the predicted cumulative probability of an observation being at or below a given level on the dependent variable. For instance, in our model, the first threshold parameter (salary = 1) was used in predicting the probability of being in the lowest outcome category (low-salary group), the second threshold parameter (salary = 2) was used in predicting the cumulative probability of

being in either the first (low-salary group)or second lowest outcome category (median-salary group), etc.

We had 905 respondents in total. The level of salary was calculated based on the median salary ((€2,001-€3,000). We coded those who earned a salary higher than the median as the high-salary group (coded as 3) and lower than the median as the low-salary group (coded as 1), thus coding the median as 2. Our response variable, salary, was treated as ordinal under the assumption that the levels of salary have a natural ordering (low to high). The gender was coded as "women" = 1 and "men" = 0 and years since PhD completion as "3 years or more" = 1 and "less than 3 years" = 0.

Importantly, since the fit statistics of ordinal models are very sensitive to empty cells, we avoided using multiple predictors in this model. Results indicated that the model provided a statistically significant improvement over the constant only model, χ^2 (2) = 46.61, p<.001, Nagelkerke pseudo R^2 = .07 (Cox and Snell = .05). The assumptions of this model (the normality of residuals, homoscedasticity, proportionality of odds, etc.) have been validated.

Table 2. Ordinal logistic regression analysis on the likelihood of PhD holders being in the high salary category based on gender

	B	S.E.	Wald	df	p-value	Exp(B)	95% C.I.for EXP(B)	
							Lower	Upper
Threshold (salary=1)	-2,187	,166	173,300	1	,000	,112	,08	,16
Threshold (salary=2)	2,236	,170	172,639	1	,000	9,352	6,70	13,05
Gender	-,578	,163	12,550	1	,000	,561	,41	,77
3 years or more vs less	,975	,173	31,614	1	,000	2,652	1,89	3,73

The significant variables are in bold.

6.4. Figures illustrating the correspondence between acquired and used skills

Figure 1. Proportion of PhD holders who reported having acquired a skill by the end of the doctorate and using it as part of their job in Life and Health Sciences
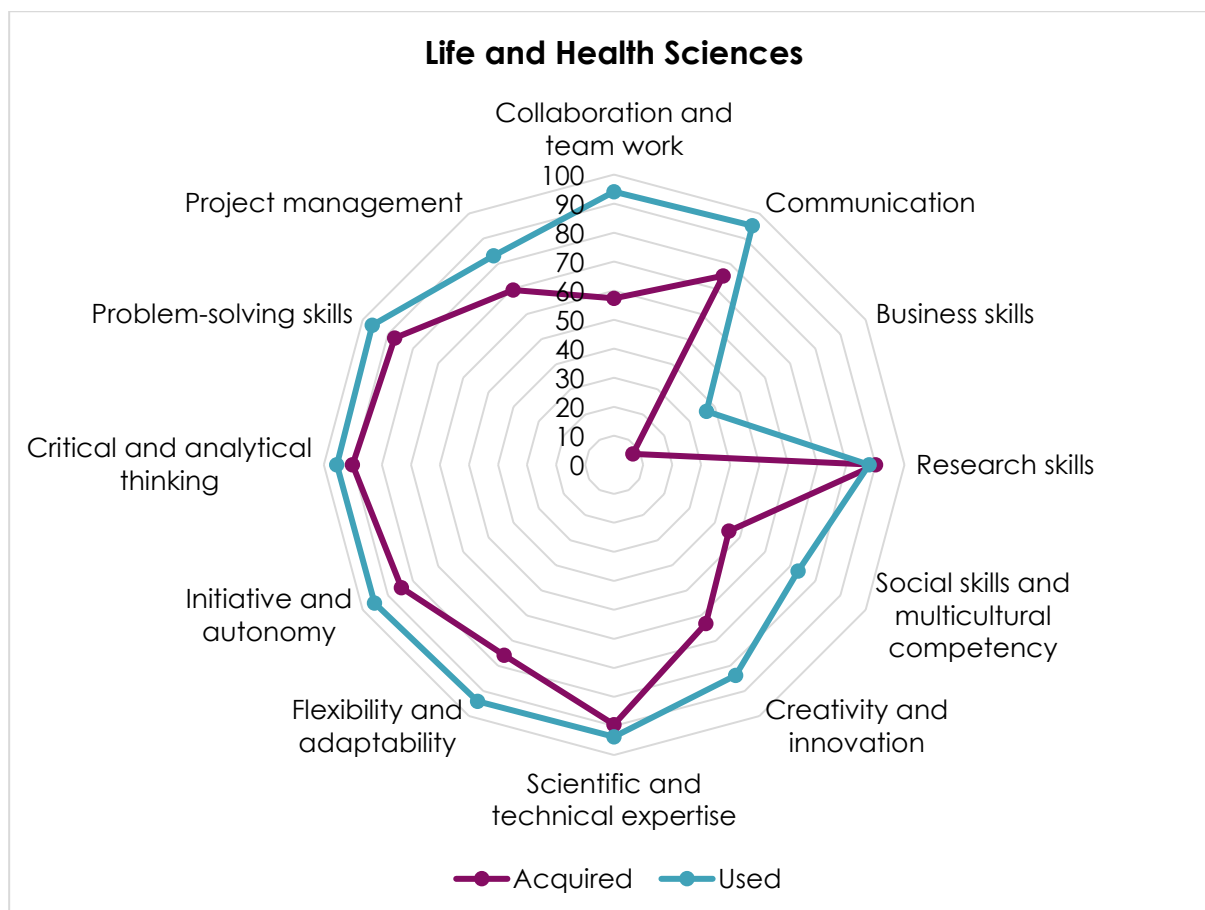
Figure 2. *Proportion of PhD holders who reported having acquired a skill by the end of the doctorate and using it as part of their job in Exact and Natural Sciences*
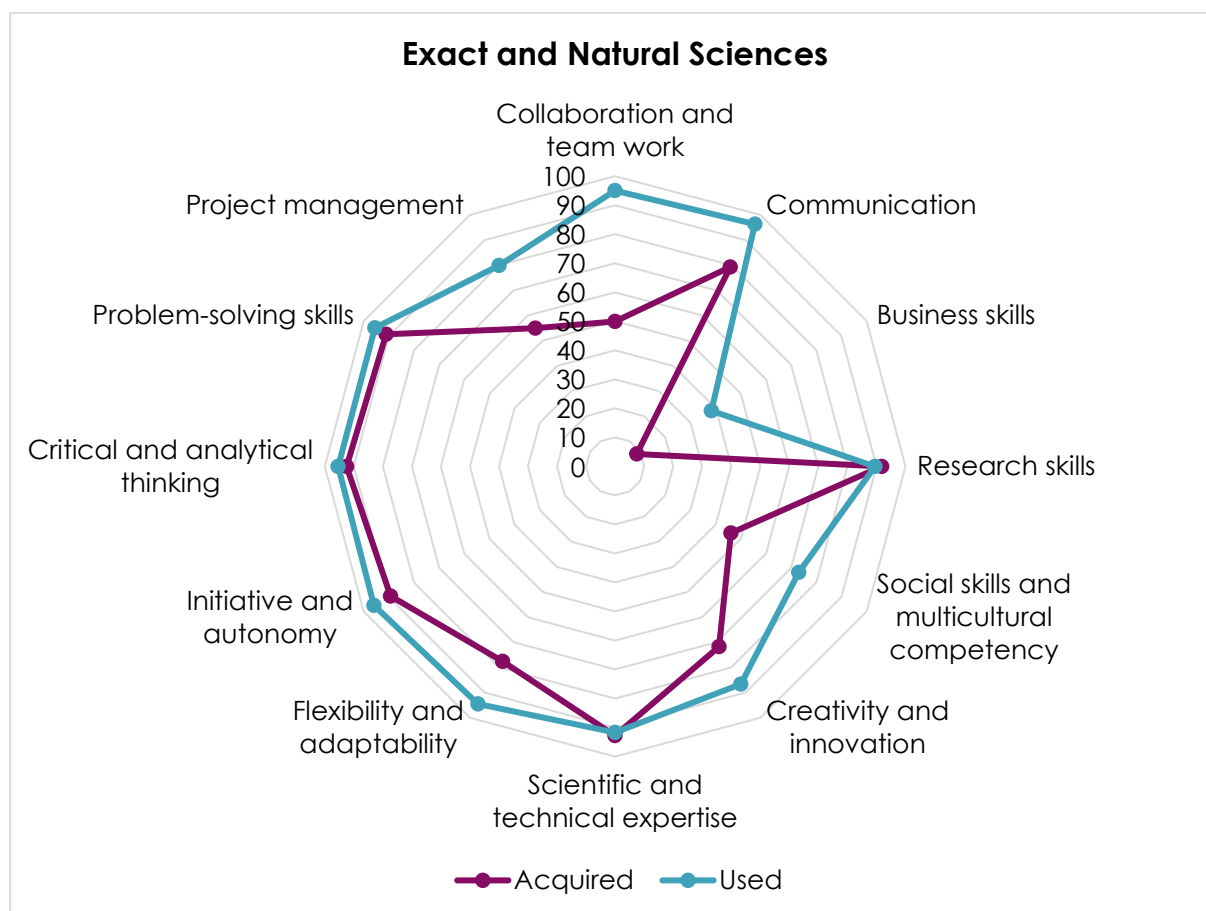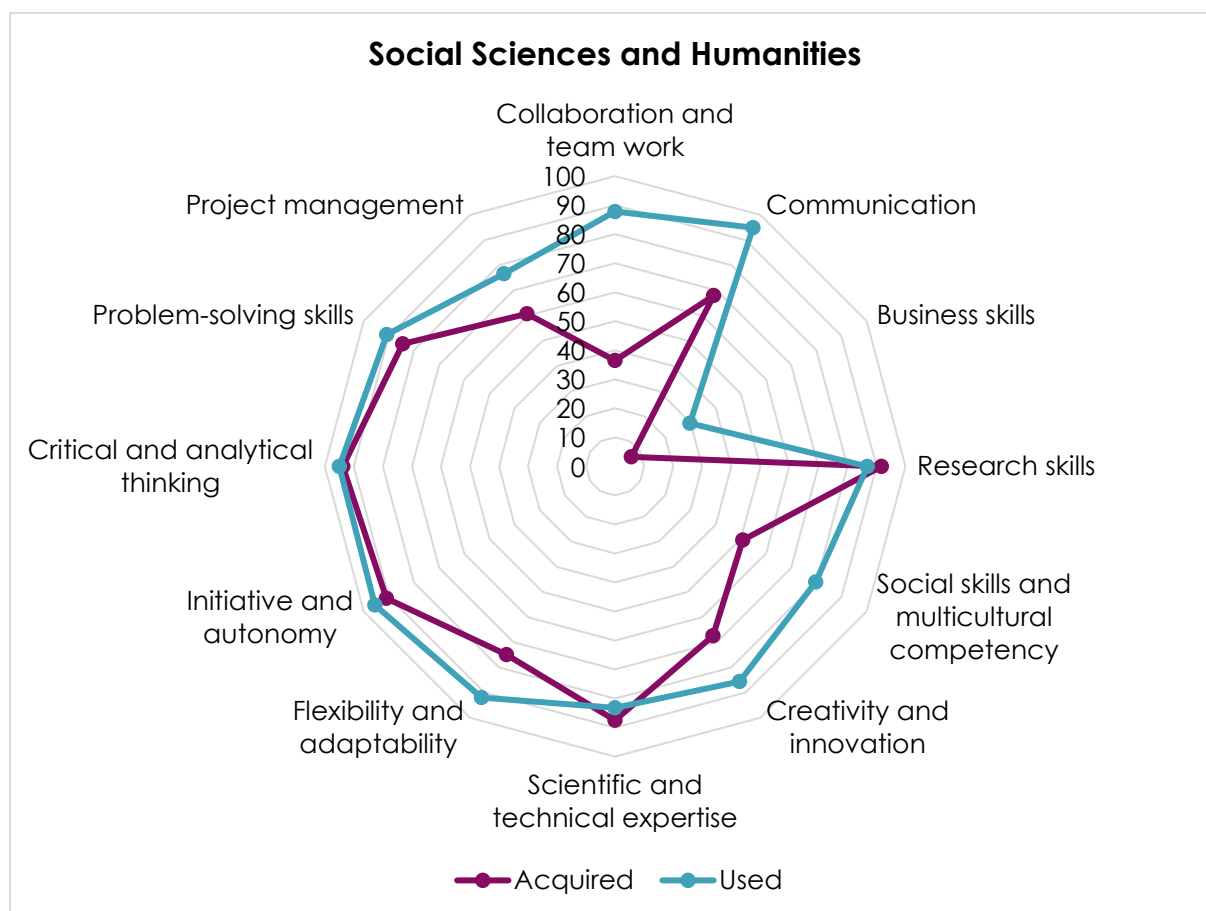
Figure 3. Proportion of PhD holders who reported having acquired a skill by the end of the doctorate and using it as part of their job in Social Sciences and Humanities

Social Sciences and Humanities

Acknowledgments