The central role of mental health and skills training, supervisor, and future career prospects in job satisfaction of postdoctoral fellows

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Abstract (252/250 words)

The postdoctoral position was originally created as a short training period for PhD holders on the path to becoming university professors. Over time, the number of postdoctoral trainees (postdocs) has exceed the number of available faculty positions. To better understand trends and the state of the postdoctoral training in the 21st century the Canadian Association of Postdoctoral Scholars – l’Association Canadienne des Stagiaires Postdoctoraux (CAPS-ACSP) conducted three professional national surveys in 2009, 2013, and 2016 of postdocs working in Canada and Canadian postdocs working internationally. We investigated longitudinal changes in postdoctoral demographics and career goals, as well as used the 2016 data to develop a path model for predicting postdoctoral training satisfaction using structural equation modelling. Our analysis revealed an aging cohort of postdocs, with positive trends towards gender equity in earnings. The strongest predictors of satisfaction with career training were opportunities for skills development, mental health symptoms, and level of encouragement from supervisors. Predictors of satisfaction with compensation were salary, skills training, mental health, and encouragement from supervisors. To investigate the importance of mental health, we also quantified the extent that mental health factors mediated the effects of significant predictors of satisfaction. This first in-depth analysis of mental health symptoms illuminates the postdoc experience in academia. Our results add to other international research findings on postdoctoral training and indicate that adjustments to training policies, such as prioritizing access to physical and mental health services, and better preparation for non-academic training goals, are critically needed to improve both intrinsic and extrinsic job satisfaction.
Key words:
postdoctoral training; research; knowledge-based economy; satisfaction; mental health

Introduction

A postdoctoral fellow, scholar, researcher, or trainee (i.e., a postdoc) is defined as ‘an individual holding a recently completed research doctoral degree or medical professional equivalent in a temporary period of mentored research or scholarly training on the road to a career as an independent researcher’ (Mitchell et al. 2013). They are important human capital in knowledge-based economies and are major contributors to research, innovation, arts, culture, science, and policy-making throughout the world (Edge and Munro 2015; Igami et al. 2015). Postdocs contribute disproportionately more to research productivity when compared to other academics (Black and Stephan 2010; Savoir 2014; Vogel 1999; Wallach 2017). For example, Canadian postdocs in the health sciences on average published more articles when compared to professors or doctoral students (Barbosa and Larivière 2014). In addition to contributing novel findings to their respective fields, postdocs also provide day-to-day supervision and mentorship of students and other research staff, while playing key roles in knowledge transmission and the establishment of collaborative research networks (Black and Stephan 2010). Most importantly, postdoctoral appointments are the platform from which new researchers embark on independent careers (Davis 2009).

Traditionally, postdoctoral appointments have been viewed as short-term positions intended to bridge the gap between completion of a PhD and employment as a university professor. In more recent years, the hypercompetitive job market has forced many trainees to engage in a series of postdoctoral appointments in pursuit of academic careers. These successive positions may span five or more years (Daniels 2015; Jadavji et al. 2016; Mitchell et al. 2013; Offord et al. 2017; Rockey 2012; Stanford et al. 2009; Yang and Webber 2015) and have led to a phenomenon known
as the ‘postdoc pile up’ (K. Powell 2015). The ‘postdoc pile-up’ refers to the growing number of postdocs stuck in the training pipeline due to a shortage in the number of academic positions available relative to the number of trainees (Grinstein and Treister 2017). The increasing length of time spent in postdoctoral positions has been described in many countries worldwide, indicating that this is a global and long-term phenomenon (Grinstein and Treister 2017; Helbing, Verhoef, and Wellington, 1998; Jadavji et al. 2016; Polka et al. 2015; Powell 2015).

At risk during this extended time of training is job satisfaction (Davis 2009; Washington 2005). Aspects of the postdoctoral experience associated with satisfaction might include both tangible factors, such as salary and resources, and less-tangible factors, such as support by supervisors and opportunities for skill development (Åkerlind, 2005; Davis 2005). The idea that distinct orthogonal factors can represent job satisfaction was first introduced by Herzberg in 1959 (Alshemri et al. 2017). These satisfaction factors exist along two separate continuums, representing an intrinsic and an extrinsic dimension. Motivators of intrinsic satisfaction are less tangible and, when available, lead to satisfaction, but not necessarily dissatisfaction, on the job. In contrast, tangible extrinsic factors are those that, if not met, can lead to job dissatisfaction. Thus, one may have high intrinsic satisfaction (e.g., generous support and encouragement), but also a conflicting high extrinsic dissatisfaction (e.g., low salary). For example, postdocs working in Holland reported fairly high levels of intrinsic satisfaction, such as guidance from supervisors, but less satisfaction with career prospects and work-life balance (van der Weijden et al. 2016). With reduced satisfaction there is a risk of these highly trained personnel leaving academia, which results in several negative consequences, including loss of personal investment. There is also a cost to the public, who has invested in training these highly trained personnel and a loss to research as well as contributions to knowledge-based economy.
We also considered postdoc mental health as a separate predictor of job satisfaction, and a potential mediator of effects from intrinsic and extrinsic satisfaction motivators. As knowledge-based economies grow, so does the understanding that structures that support mental health are critical to maintaining an optimal workforce capacity (Engelbrecht 2012). As a critical segment of this workforce, warning signs regarding issues with postdoc mental health will need to be taken seriously. For example, Dorenkamp and Weiß (2018) found that heightened job stress among postdocs lead to greater levels of intention to leave academia (Dorenkamp and Weiß 2018).

Previous work with the Canadian postdoc population has identified key concerns of postdoctoral training including lack of benefits, low pay, increased time in position, and concerns about career advancement (Helbing et al. 1998). To better understand trends and the state of the postdoctoral training in the 21st century, the Canadian Association of Postdoctoral Scholars – l’Association Canadienne des Stagiaires Postdoctoraux (CAPS-ACSP) conducted national surveys of postdocs working in Canada and Canadians working internationally in 2009 (Stanford et al. 2009), 2013 (Mitchell et al. 2013), and 2016 (Jadavji et al. 2016). The present study reports on the longitudinal changes in the postdoc population using data collected from the three professional national surveys and identifies intrinsic and extrinsic motivators of job satisfaction using the data collected in the 2016 survey (Herzberg 1959; Herzberg et al. 2011). Postdoc mental health was investigated via 11 survey items that served as indictors of mental health and an analysis of verbatim comments using a qualitative and mental health and well-being theme. Findings report on trends in the postdoctoral landscape from 2009 to 2016 and outline two models of job satisfaction. Results point to specific actions that can be taken by stakeholders to improve the experience and outcomes of postdoctoral training. In particular, the prevalence of mental health
symptoms is explored and investigated as a mediator of both intrinsic and extrinsic motivators of job satisfaction.

**Survey Methodology**

The CAPS-ACSP 2009, 2013, and 2016 professional surveys covered demographic and funding details, postdoc well-being and satisfaction, and career goals and outcomes. Where survey questions aligned in at least two national surveys, an examination of longitudinal trends was undertaken. For more details on survey questions, please refer to individual reports 2009 (Stanford et al. 2009), 2013 (Mitchell et al. 2013), and 2016 (Jadavji et al. 2016).

Demographics of the survey respondents for each year are presented in Table 1. The population of survey respondents included Canadian citizens working in Canada and internationally, as well as permanent residents and international postdocs working in Canada.

The 2009 national survey was conducted using an online survey tool (LimeSurvey). Participants were recruited via a link on the CAPS-ACSP website. The survey was open to responses for 91 days and total of 1192 postdocs participated (Table 1). The data analysis was performed by postdocs volunteering their time with CAPS-ACSP.

In 2013, CAPS-ACSP worked with Mitacs along with the research and survey consulting firm Academica Group to conduct the national survey. To expand the breadth of the survey, representatives from all three organizations worked on survey question development, and the US Sigma Xi Postdoc Survey (Davis 2005) was also consulted. Academica Group deployed the survey in both English and French and conducted a detailed analysis. The 2013 survey was open for 39 days and total of 1830 postdocs participated (Table 1). At the end of the survey, respondents were given the option to enter their e-mail address for future research purposes.
The 2016, CAPS-ACSP survey was delivered again with the assistance of Academica Group. Input on survey questions from the Tri-Council funding agencies (Canadian Institutes of Health Research, CIHR; Natural Sciences and Engineering Research Council, NSERC; and Social Sciences and Humanities Research Council, SSHRC) was also obtained. Five new survey questions were added, one focused on mental health during training and the other four targeted towards postdocs who had completed their training. Academica Group deployed the survey in English and French and analyzed the data. The survey was open for 50 days and total of 1630 postdocs working in Canada participated (Table 1).

To address the challenge that there is no comprehensive list of all postdocs working in Canada, emails containing links to the survey were sent to postdoctoral administrators working at Canadian Universities with postdoctoral training programs available. The Tri-Council (CIHR, NSERC and SSHRC) funding agencies and Mitacs were asked to forward the survey to the postdocs in their databases. Institutional postdoctoral associations and the CAPS-ACSP membership were also sent e-mails with survey links.

**Training satisfaction analysis**

Satisfaction with postdoctoral training was queried in the 2016 survey. As shown in Figure 5, a path model was developed using partial least squares structural equation modelling to examine the latent structure of satisfaction with postdoctoral training, and the most salient predictors of postdoc satisfaction. The indicators and measures included in the model were derived from the 2016 survey responses. The structure of the model and composition and quality of the latent variables were analyzed using WarpPLS 6.0 (Kock 2017).
Outcome Variable

The latent outcome variable, postdoc satisfaction, was initially reflected by 11 indices of satisfaction. Survey respondents were queried regarding satisfaction with their salary, benefits, opportunities for collaboration, resources and facilities, career development and options, professional training, work environment/interaction, level of supervision/independence, and work-life balance. The queries were answered using a five-point Likert scale that ranged from “completely disagree” to “completely agree”. As shown in Table 2, hypothesized motivators of satisfaction were categorized as either intrinsic or extrinsic in accordance with Herzberg (Herzberg 1959, 2005; Herzberg et al. 2011). Intrinsic factors centered on professional development and recognition, whereas extrinsic are related to policies, such as wages, benefits, and job security. Two additional ratings of overall satisfaction with the postdoctoral experience and the value of the training were also examined.

Predictor Variables

Predictors of postdoc satisfaction were developed from queries in the 2016 survey that followed a categorical, scale, or ordinal response format and indexed various aspects of the postdoctoral experience. Potential predictors (with number of representative items) of postdoctoral training satisfaction included concern with encouragement from supervisors (1 item), certainty of achieving the desired goal (1 item), quality of skills training (5 items), non-academic career preparation (3 items), time allocated to various aspects of the training (8 items), professional priorities (10 items), annual salary (1 item), and mental health (11 items). These individual predictor variables represented a broad range of factors that could influence satisfaction with the postdoctoral experience. The structural model was also designed to test the mediating influence of mental health, whereby the effects from all predictors significantly associated with mental health
were tested to determine whether they were significantly mediated by the mental health variable. The model was analyzed using age, gender, and location of postdoc (within or outside of Canada) as control variables.

Results

Longitudinal analysis of 2009, 2013, and 2016 surveys

The postdoc population is aging

The results from 2009, 2013, and 2016 surveys suggest a shift in the age distribution of postdocs working Canada and Canadians working internationally. The percentage of postdocs in the two younger categories, age 25 to 29 and age 30 to 34 years, has decreased since 2009 (Figure 1). Meanwhile, in 2016, 31% of current postdocs were 35+ years old; the proportion of postdocs in this age group has increased eight percentage points since 2009.

As shown in Figure 2A, the number of married postdocs in 2016 increased from 2009. No data on the number of single, never married or divorced/widowed postdocs was collected in the 2009 survey. There were more postdocs with children in 2016 as compared to 2009 (Figure 2B). Our analysis shows that there was a concomitant increase (15.6 % to 19.0%) in the need for paid parental leave from 2013 to 2016. In 2016, the percentage of past postdocs with dependents was 47%, as compared to current postdocs (31%). A comparison of desired benefits from the 2013 and the 2016 surveys also suggests a maturing cohort, with needs that reflect typical family-related concerns. For example, there was an increase in the desire for paid parental leave from 16% (2013) to 19% (2016).

Career goals of postdocs
The 2013 and 2016 surveys examined the career goals of postdocs before beginning their postdoctoral appointment. As shown in Figure 3, the tenure-track position was, and is, the primary initial career goal for more than 70% of postdocs. However, there is a trend from 2013 to 2016 for fewer postdocs (~5%) to begin with a tenure-track career goal. In 2016 more postdocs selected other career options, such as industry and private sector research, public service, and consulting or non-government organization as their primary career goal.

**Gender representation among postdocs**

A clear trend across the three surveys was the increasing proportion of female postdocs (Figure 4A). While there remain slightly more males than females in postdoctoral positions, the gap has closed by 2016. More importantly, there were no gender differences in rate of pay between male ($47,847.34 CAD) and female postdocs ($47,751.76 CAD). Despite the increasing number of female postdocs and similar reported earnings between genders, there was a pattern of lower satisfaction with career options for women that persisted from the 2013 survey (Figure 4B). Post hoc analysis of the association of gender to number of postdoctoral appointments found no significant relationship in the present study.

**Postdoc Mental Health**

Postdoc mental health was posited as a potential mediator of both intrinsic and extrinsic motivators of satisfaction and was therefore examined in detail. About 75% of respondents indicated experiencing serious thoughts, feelings, or conditions related to their mental health during their postdoctoral appointment. Approximately 75% of respondents who reported negative symptoms also reported multiple symptoms, with the majority of these respondents indicating three or more symptoms. As shown in Figure 6, the most commonly reported experiences (lasting
for a month or more) were feeling overwhelmed by tasks, feelings of hopelessness and loneliness, and anxiety or panic attacks. About one-quarter reported experiencing depression and insomnia, and one-fifth reporting feeling extreme sadness. Of imminent concern are the 7% of postdocs who report thoughts of self-harm or self-loathing. A Pearson correlation analysis found that scores on the “overall satisfaction: survey item correlated significantly with the number of negative mental health symptoms experienced by respondents ($r = -0.27, p < 0.001$). Thus, as negative symptoms increased overall satisfaction decreased.

Comments from survey respondents to the 2016 Survey were examined for themes pertaining to mental health and well-being. This qualitative analysis pointed to relationships with supervisors as a pivotal factor in postdoc stress. Some postdocs reported having excellent relationships with their supervisor; this giving way to overall better postdoc experiences. In other cases, troublesome interactions with supervisors were described using terms that reflect harassment, bullying, and lack of support. Some postdocs reported feeling as though they are “at the mercy” of their supervisor. Only two-fifths of postdocs indicated that they had access to extended health benefits, the point of access for mental health services.

**Postdoc satisfaction with training, career, and compensation**

In regard to overall satisfaction with postdoctoral training, the 2016 survey indicated that about half the respondents were at least somewhat satisfied. However, more postdocs were either ambivalent or dissatisfied as compared to the number of completely satisfied postdocs. The results of the 2016 survey items pertaining to satisfaction with various elements of the postdoc experience are shown in Figure 7. The highest satisfaction ratings were found for workplace characteristics,
such as supervision level and independence, resources, peer interaction and collaboration opportunities. Satisfaction levels were relatively-low for factors associated with work and life balance, extra funding for travel, career development and training. The lowest satisfaction was noted for salary and benefits.

As shown in Figure 5, the structural path model for determining predictors of postdoc satisfaction was originally constructed as a variety of factors directly predicting one latent postdoc satisfaction outcome variable. In accord with the survey items, some predictors were represented as latent constructs (e.g. professional priorities, quality of skills training, mental health, and non-academic career preparation), and others as single indicators (e.g. annual salary, encouragement from supervisor, certainty of reaching goal, and time available for research). All control variables were represented as single-indicator variables (data not shown).

**Measurement model testing**

Before examining the structural relationships between variables in the SEM, measurement model analyses using confirmatory factor analysis were completed for each latent variable in the SEM. As per convention, when loadings were significant and in the expected direction, they were retained for the final outer measurement models, see Figure 8 for the structure of each predictor variable (Kline 2005). With respect to the satisfaction outcome variable, we found that two latent satisfaction constructs, rather than a single factor, better represented the concept of satisfaction. Each of these two satisfaction constructs fell along the lines of either extrinsic (e.g. compensation) or intrinsic (e.g. training and career) factors (Table 2). An initial analysis of the loadings from all 11 items of satisfaction on one factor found that three key factors loaded poorly (less than 0.5). When the two-factor structure was tested the
cross-loadings between the indicators and the other construct were low (less than 1), thus validating the use of two latent satisfaction constructs (Table 3).

As shown in Figure 8, the first satisfaction construct was composed primarily of intrinsic factors pertaining to training and career-related activities (e.g., resources such as funds for research and travel), collaboration, and work environment and supervisory factors. Extrinsic satisfaction (compensation factor) was reflected by salary, benefits, and work-life balance.

A measurement model was also tested for each latent predictor variable. Also shown in Figure 8 are the indicators found to significantly reflect each of professional priorities (six items), mental health (eight items), quality of a variety of skills training (five items), and non-academic career preparation (three items). These tests resulted in measurement models with high to moderate quality indices, such as average variance extracted (> 0.5) and model reliability (> 0.7).

**Structural model results**

Most predictors had small to medium effects on the satisfaction constructs. In Figure 8, when an arrow from a predictor to either of the satisfaction factors is not present, this indicates the lack of a significant relationship between predictor and outcome variable. For example, the non-academic career preparation factor was associated with satisfaction with training and career issues but was not significantly linked to satisfaction with compensation. The relative predictive strength for each significant predictor variable for the two satisfaction constructs and the mental health construct is illustrated in Figure 9. As is often found in SEMs with large sample sizes, links between constructs may be statistically significant but offer little in the way of explained variance of the outcome variables. Thus, effects less than .02 were removed from Figure 9 due to their practical insignificance in explaining the outcome factors (Cohen 1988).
More than half the variance ($r^2 = .58$) of the intrinsic job satisfaction factor was predicted by the model (Figure 8). As shown in Figure 9, quality ratings for a variety of skills training was the strongest predictor of intrinsic satisfaction. The remaining variance in intrinsic satisfaction was predicted similarly by encouragement from supervisors, non-academic preparation certainty of reaching goal, and mental health symptoms.

Extrinsic job satisfaction was less well-predicted, ($r^2 = .27$), with the majority of variance predicted by salary, and the remaining similarly predicted by mental health symptoms, skills training, concern over professional priorities, and encouragement from supervisors. Further post hoc analysis of annual salary and satisfaction was undertaken to explore how income might affect compensation-related motivators of satisfaction. The average salary of postdocs working in Canada in 2016 was shown to be just under 48,000.00 CDN. A positive linear relationship of salary to satisfaction with compensation was found, accounting for just under half the variance. It should be noted that a substantial increment in salary (from about $25,000.00 to 85,000.00 CDN) resulted in only a minor average increase in satisfaction (1.5 points on the 5-point scale).

Mediation of effects by mental health

Mediation effects were tested individually with simple three variable models (predictor $\rightarrow$ mental health $\rightarrow$ satisfaction construct). For all predictors that correlated significantly with mental health (see Figure 9), we tested for the mediation of effects from these predictors on the satisfaction constructs via mental health. For example, as listed in Table 5, effects from skills training on career and training and compensation satisfaction factors were significantly mediated by mental health. Similarly, small but significant effects from encouragement from supervisor, non-academic career
preparation, and certainty of reaching career goal on career and training satisfaction were mediated by mental health.

Discussion

Recent data has suggested that the postdoctoral training is changing (Daniels 2015; Helbing et al. 1998; Jadavji et al. 2016; Mitchell et al. 2013; Offord et al. 2017; Rockey 2012; Stanford et al. 2009; Yang and Webber 2015). The aim of this study was to examine the longitudinal changes and the factors affecting satisfaction with training in the postdoc population working in Canada and Canadian postdocs working internationally. Our longitudinal analysis revealed that the demographics of the average postdoc are changing: we observed an increase in the average age of postdocs and those married and with dependents. In terms of training satisfaction, quality of skills training, encouragement from supervisors, and prior knowledge of career prospects were the three strongest predictors of satisfaction. Our results resonate with other international research findings, which indicate that action is needed if countries wish to continue to attract and retain high-quality postdocs (Ahmed et al. 2015; Daniels 2015; Helbing et al. 1998; Offord et al. 2017). These trends are discussed in more detail below.

The Changing Demographics and Family Structure of Postdocs

There are too many postdocs competing for limited tenure-track positions (Daniels 2015; Offord et al. 2017). For example, in 2004, there were 8000 PhD recipients, and in 2014 this number increased to 12,500 (Offord et al. 2017). There have been no similar increases in the number of faculty positions (Larson et al. 2014). In response to this challenging job market, some postdocs will extend their training in various roles to build a more competitive application (Grinstein and Treister 2017; Helbing et al. 1998).
Longer postdoctoral tenures may be one explanation of why we are seeing a shift in the average age of postdocs. The trend of the aging postdoc worldwide is part of the phenomenon known as the ‘postdoc pile up’ (K. Powell 2015). The ‘postdoc pile-up’ has also been described in China (Ahmed et al. 2015), Britain (Halford 2013), Holland (van Teelken et al. 2016), Germany (Fitzenberger and Leuschner 2012) and Canada (Jadavji et al. 2016). The long-term postdoc problem was observed more than 40 years ago and was associated with gender and nationality issues. The National Academies (1969) noted that the long-term postdoc was three times more likely to be female and one and a half times more likely to be foreign-born (“National Academies.” 1969).

**Career Goals of Postdocs**

Career goals of postdocs are changing, as more postdocs are pursuing industry or private sector research and public service jobs. A recent report showed that biomedical PhD holders who choose jobs in academia (e.g. postdoc) on average give up their earning potential when compared to those who entered non-academic positions (Grinstein and Treister 2017; D. Powell 2017). With reduced earning potential and excessive competition for tenure-track positions, academia may fail to attract the best and brightest young researchers for these keystone roles, to the detriment of research and innovation worldwide. There has also been work suggesting that there is a decline in pursuing academic careers begins during graduate training (Grinstein and Treister 2017; Roach and Sauermann 2017). Approximately 25% of doctoral students in science and engineering completely lose interest in pursuing a career in academia over the course of their training (Roach and Sauermann 2017). In the US, reduced interest in academic careers during graduate school is translating to a reported decrease in the number of biological and medical science postdocs.
working (Garrison et al. 2016). Postdocs contribute research productivity in their respective fields and thus play a role in the knowledge-based economy, so the loss of these individuals could have a negative impact in several different areas.

**Gender Representation**

One important finding of our longitudinal study was the equity in compensation between the genders. Despite this, female respondents reported lowers levels of satisfaction when compared to their male colleagues. The pipeline theory may explain why women are less satisfied with their careers and underrepresented in higher-paying academic roles (White 2004). First, this theory predicts that fewer women enter the pipeline, which ranges from undergraduates to tenure-track faculty. On this notion, affirmative action programs designed to increase the number of women entering higher education will eventually improve outcomes for women at the end of the pipeline. Over the past 20 years the number of women entering the pipeline has grown to similar levels as males, for some, not all research domains, but outcome disparities continue to exist (Schweitzer et al. 2011). The second facet of pipeline theory suggests that women are disproportionately siphoned out of the pipeline between the doctorate and junior faculty level (White 2004). For some, this leaky segment of the pipeline represents the postdoctoral years. It may be possible that female researchers were discouraged in their postdoctoral years by isolation, long work hours, lack of mentorship, and inflexible workplace policies regarding leave and childcare (White 2004). Furthermore, females had lower expectations for salary and career advancement than males at the start of their academic preparation (Schweitzer et al. 2011). The theory by Schweitzer et al. (2011) is supported by the 2016 Survey, where female postdocs show a consistent trend towards lower levels of satisfaction with career options, as compared to male postdocs. The tendency to begin
academic careers with lower expectations is influenced by field of study; for example, women in male-dominated fields indicated higher expectations for earnings and advancements in comparison to women in female-dominated fields (Schweitzer et al. 2011). These results suggest that expectations are linked to satisfaction, thus fostering more realistic expectations early on in postdoctoral training may positively impact training satisfaction for women.

Training Satisfaction & Mental Health

Understanding the factors that contribute to postdoc satisfaction with training and compensation can inform strategies designed to improve the training experience, positively influence training outcomes, and attract high-quality PhDs to postdoctoral programs. In our study, when asked about a variety of aspects of the postdoctoral experience, ratings of “complete satisfaction” ranged from about 10-40%. For most items, respondents were more likely to be “somewhat satisfied.” Results of the CAPS-ASCP 2016 Survey are less positive than those from a survey of U.S. postdocs where 70% of respondents indicated overall satisfaction with the postdoctoral training (Davis 2005). The present findings reflect those of a study of Dutch postdocs, which also indicated lower levels of satisfaction with career prospects and work-life balance when compared to their satisfaction with contact with colleagues, workplace conditions, and supervisor guidance (van der Weijden et al. 2016). Furthermore, there is concern over the possibility that satisfaction with the training may erode across multiple postdoctoral appointments. Longer postdoc appointments and reduced satisfaction has been reported prior to our study in the Canadian population (Helbing et al. 1998). This decrease in satisfaction over time was noted by van der Weijden et al. (2016), wherein greater numbers of appointments were associated with less satisfaction. Similarly, Vandenberg and Lance (1992) found that job satisfaction for young
professionals was a result of organizational commitment, where greater commitment lead to increases in experienced job satisfaction (Vandenberg and Lance 1992). Thus, as postdocs experience decreasing levels of commitment with their position, such as may occur when the likelihood of obtaining the coveted faculty appointment appear to dwindle, satisfaction with postdoctoral positions may also wane.

Work-related mental health issues (e.g. work-related stress) impose a significant health and economic burden to the employee, the employing organization, and the country of work more generally (Van Gordon et al. 2014). The 2016 survey indicated that three-quarters of the respondents experienced one or more persistent negative mental health symptoms, such as feeling overwhelmed by tasks, hopelessness, loneliness, anxiety, and depression. To better understand the depth of this problem one can examine the prevalence of these symptoms in the 30-something population. For those in the “millennial” age range, as are most postdocs, women and low-income are the most likely to experience mental health issues (Ipsos 2018). Also, for this age range, suicide is the third leading cause of death (Government of Canada 2016). Although universities were traditionally regarded as low stress environments, occupational stress among academics indicates that it is alarmingly widespread and, on the rise. Studies suggest that stress in more prevalent in younger academics, a group that typically faces high levels of job insecurity (Levecque et al. 2017). The relationship between mental health and academic performance was robust in a variety of analysis (Hysenbegasi et al. 2005).

In light of our finding that respondents reporting negative symptoms tended to experience multiple persistent symptoms (on average, three symptoms) it is critical that postdocs have access to extended health benefits to connect with mental health services when needed. Over half of the 2016 Survey respondents also indicated that they expect to be a postdoc for three years or more,
making persistent chronic stress a possibility. Chronic stress is known to have negative effects on health, including physical and mental well-being. In a twenty-year review, Ganster and Rosen, (2013) discuss critical end points of workplace stress that include diabetes, cardiovascular disease, and depression, which result from the cortisol dysregulation brought about by sustained stressful environments (Ganster and Rosen 2013). The central role of mental health was found in our study, with mental health mediating effects from four predictors of postdoc satisfaction. Thus, long-term postdocs in stressful environments may be vulnerable to both compromised health, including issues that can impact health across the lifespan, such as diabetes, and lower levels of satisfaction.

Results of the modeling revealed that postdoc satisfaction could be appropriately characterized according to the theory of intrinsic and extrinsic dimensions of satisfaction as described by Herzberg (Herzberg 1959, 2005; Herzberg et al. 2011). Over half the variance in the intrinsic satisfaction factor was explained, with most of this predicted by variety in skills training and encouragement by supervisors. However, this general satisfaction factor was also similarly predicted by non-academic goal preparation, certainty of reaching the goal, and mental health issues. By far, the best predictor of the outcome satisfaction construct for skills and training was the latent construct comprised of quality ratings for research, teaching, management, communication, and networking skills training. Davis (2009) found that two factors best explained satisfaction with the postdoctoral tenure: formal oversight and professional development, with structured oversight showing the most potential for improving postdoc satisfaction (Davis 2009). While encouragement from supervisors predicted both the intrinsic and extrinsic factors, in our 2016 study, the quality of the training was the stronger predictor of job satisfaction.

Comparatively, just over a quarter of the variance in the extrinsic factor was explained, with predictors more equally spread across five variables. These results show that satisfaction with
compensation was supported by more than the tangible predictors, such as salary and benefits, but was also positively influenced by mental health issues, variety of skills training, encouragement by supervisors, and concern with professional issues. Support for this notion is also shown in our measurement model for the compensation satisfaction factor, where work-life balance was found to associate with the satisfaction construct just as strongly as salary and benefits. Of concern in our findings is that according to the Herzberg (1959) dual-factor theory of job satisfaction, the low levels of satisfaction for compensation factors we observed could represent significant dissatisfaction with the postdoctoral training experience. In a study of German postdocs that investigated intention to abandon career goals, an effort-to-reward imbalance was shown to directly influence their intention of leaving academia and their profession (Dorenkamp and Weiß 2018). In addition, as postdocs reported greater incongruency between their compensation and their work efforts there was a concomitant increase in work strain and decrease in work satisfaction.

Conclusion

The results from our study suggest adjustments of guidelines for postdoctoral training are critically needed. With limited faculty positions, it may be prudent to encourage postdocs to use their skills in careers outside academia (e.g. government, industry). From our analysis we suggest the following, recruit postdocs for careers supported by market demands, so that postdocs can transition easily into the labor force once their training is complete. Similarly, stakeholders must encourage postdocs to pursue careers outside of academia through increased exposure to these career options during training. Increased support for current postdocs, for example, addressing the needs of the aging postdoc population by defining employment status, so that social support
programs can be accessed, including 12-month parental leave. Countries should adopt competitive salary scale including increases to accommodate inflation, and experience, similar to those in the United Kingdom and United States.

Worldwide, postdocs are an essential component of a knowledge-based economy and drivers of research advancement and innovation. Our study highlights the need for positive changes to address the challenges facing postdoctoral training in the 21st century.
Table 1. Demographics of all survey respondents from 2009, 2013 and 2016 Canadian Association of Postdoctoral Scholars (CAPS) – l’Association Canadienne des Stagiaires Postdoctoraux (ACSP) national surveys. Data is presented as percentage of respondents. Respondents included postdocs working in Canada and Canadians working internationally.

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<tbody>
<tr>
<td>Number of respondents</td>
<td>1192</td>
<td>1830</td>
<td>1630</td>
</tr>
<tr>
<td>Length of Survey (days)</td>
<td>91</td>
<td>39</td>
<td>50</td>
</tr>
<tr>
<td>Percentage of respondents by discipline</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Life Sciences</td>
<td>63</td>
<td>46</td>
<td>45</td>
</tr>
<tr>
<td>Physical Sciences/Engineering</td>
<td>23</td>
<td>32</td>
<td>28</td>
</tr>
<tr>
<td>Social Sciences/Humanities</td>
<td>11</td>
<td>14</td>
<td>16</td>
</tr>
<tr>
<td>Interdisciplinary</td>
<td>unknown</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Percentage of respondents by gender</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>56</td>
<td>53</td>
<td>51</td>
</tr>
<tr>
<td>Male</td>
<td>44</td>
<td>46</td>
<td>48</td>
</tr>
</tbody>
</table>
Table 2. Hypothesized intrinsic and extrinsic motivators of satisfaction.

<table>
<thead>
<tr>
<th>Index of satisfaction</th>
<th>Intrinsic or extrinsic motivation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Salary</td>
<td>Extrinsic</td>
</tr>
<tr>
<td>Benefits</td>
<td>Extrinsic</td>
</tr>
<tr>
<td>Opportunities for research collaboration</td>
<td>Intrinsic</td>
</tr>
<tr>
<td>Resources and facilities</td>
<td>Extrinsic</td>
</tr>
<tr>
<td>Funds for research and travel</td>
<td>Extrinsic</td>
</tr>
<tr>
<td>Career development</td>
<td>Intrinsic</td>
</tr>
<tr>
<td>Professional training opportunities</td>
<td>Intrinsic</td>
</tr>
<tr>
<td>Work environment/peer interaction</td>
<td>Intrinsic</td>
</tr>
<tr>
<td>Level of supervision/independence</td>
<td>Intrinsic</td>
</tr>
<tr>
<td>Work-life balance</td>
<td>Both Extrinsic and Intrinsic</td>
</tr>
</tbody>
</table>

\(^1\text{Categorization of intrinsic versus extrinsic motivation is based on work by Herzberg 1959, 2005; Herzberg et al. 2011.}\)
Table 3. Loading values of each satisfaction indicator with its respective latent construct.

<table>
<thead>
<tr>
<th>Satisfaction Factor</th>
<th>Indicator</th>
<th>Loading</th>
<th>Cross-Loading</th>
<th>Factor Quality Coefficients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compensation</td>
<td>Salary</td>
<td>-0.782</td>
<td>-0.04</td>
<td>Cronbach’s Alpha = 0.541</td>
</tr>
<tr>
<td></td>
<td>Benefits</td>
<td>-0.738</td>
<td>-0.072</td>
<td>Composite Reliability = 0.766</td>
</tr>
<tr>
<td></td>
<td>Work/life balance</td>
<td>-0.645</td>
<td>0.131</td>
<td>Average Variance Extracted (AVE) = 0.523</td>
</tr>
<tr>
<td>Training and Career</td>
<td>Opportunities for research collaboration</td>
<td>-0.683</td>
<td>-0.159</td>
<td>Chronbach's Alpha = 0.863</td>
</tr>
<tr>
<td></td>
<td>Resources and facilities</td>
<td>-0.563</td>
<td>0.108</td>
<td>Composite Reliability = 0.892</td>
</tr>
<tr>
<td></td>
<td>Funds for research and travel</td>
<td>-0.511</td>
<td>0.199</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Career development</td>
<td>-0.768</td>
<td>0.04</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Professional training opportunities</td>
<td>-0.695</td>
<td>0.037</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Work environment / peer interaction</td>
<td>-0.691</td>
<td>-0.085</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Level of supervision / independence</td>
<td>-0.691</td>
<td>-0.127</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Satisfaction with career options</td>
<td>-0.84</td>
<td>0.004</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Satisfaction with value</td>
<td>-0.77</td>
<td>-0.011</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Overall Satisfaction</td>
<td>-0.461</td>
<td>0.092</td>
<td></td>
</tr>
</tbody>
</table>

Note. Quality coefficients index reliability, such that indicators are shown to reflect the latent construct. Ideally Cronbach’s Alpha and Composite Reliability > 0.6 and Average Variance Extracted (AVE) > 0.5.
Table 4. *Beta* Path Coefficients from Predictors to Outcome Variables

<table>
<thead>
<tr>
<th>Predictors</th>
<th>Path Coefficients</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Training &amp; Career</td>
<td>Compensation Satisfaction</td>
<td>Mental Health Issues</td>
</tr>
<tr>
<td>Annual Salary</td>
<td>0.075</td>
<td>0.286</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time Available for Research</td>
<td>0.073</td>
<td>0.04 (ns)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Professional Priorities</td>
<td>-0.069</td>
<td>-0.109</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mental Health Issues</td>
<td>-0.137</td>
<td>-0.166</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Encouragement from Supervisor</td>
<td>0.181</td>
<td>0.121</td>
<td>-0.129</td>
<td></td>
</tr>
<tr>
<td>Certainty of Reaching Goal</td>
<td>0.122</td>
<td>0.055</td>
<td>-0.161</td>
<td></td>
</tr>
<tr>
<td>Variety of Skills Training</td>
<td>0.484</td>
<td>0.155</td>
<td>-0.114</td>
<td></td>
</tr>
<tr>
<td>Non-Academic Career Development</td>
<td>0.121</td>
<td>0.102 (ns)</td>
<td>-0.102</td>
<td></td>
</tr>
</tbody>
</table>

*Note.* All path coefficients are significant at \( p<0.05 \) unless otherwise indicated.
Table 5. Mediated Effects from Predictors of Satisfaction via Mental Health Construct (simple mediation models).

<table>
<thead>
<tr>
<th></th>
<th>Carrer &amp; Training</th>
<th>Compensation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Encoragement from Supervisor</td>
<td>0.03</td>
<td>&lt; 0.02</td>
</tr>
<tr>
<td>Non-academic career preparation</td>
<td>0.03</td>
<td>&lt; 0.02</td>
</tr>
<tr>
<td>Skills Training</td>
<td>0.05</td>
<td>0.02</td>
</tr>
<tr>
<td>Certainty of Reaching Goal</td>
<td>0.03</td>
<td>&lt; 0.02</td>
</tr>
</tbody>
</table>

*Note: Values are effect sizes, similar to Cohen’s $f^2$, p<0.01. For example, in a simple three-factor model, mental health mediated a significant portion of the variety of skills training effects on the career and training satisfaction factor.*
References


van Teelken, C., de Boer, M., der Weijden, I., & Drost, M. (2016). *To your excellent career.* (Vol. 45).


Figure Captions

Figure 1. Age of postdocs working in Canada and Canadian postdocs working internationally in 2009, 2013 and 2016. Data collected from 2009, 2013 and 2016 CAPS-ACSP Canadian National Postdoctoral Surveys. In 2009, the two middle age categories were 30 to 35 years, and 36 to 40 years as indicated by the values in brackets. In 2016, 5% of survey respondents preferred to not report their age. In the 2009 and 2013 survey’s there was no option to not report age of respondent.

Figure 2. The marital status of postdocs (A) and percentage with dependents (B). Data collected from 2009, 2013 and 2016 CAPS-ACSP Canadian National Postdoctoral Surveys. In 2009, only data on married/common-law status and the percentage of postdocs that had dependents was collected.

Figure 3. Career goals of PhD holders before starting a postdoctoral position. Data was only collected from 2013 and 2016 CAPS-ACSP Canadian National Postdoctoral Surveys.

Figure 4. The percentage of female and male respondents for 2009, 2013, and 2016 surveys (A). Satisfaction of postdocs with career options by gender for all respondents (B). For the survey item pertaining to satisfaction with career options, data was only collected from 2013 and 2016 CAPS-ACSP Canadian National Postdoctoral Surveys.
**Figure 5.** Hypothesized path model for predictors of postdoc satisfaction. Dashed arrows from predictors to Mental Health indicate that mediating effects from predictors to satisfaction factors, via the mental health factor were also examined.

**Figure 6.** Mental health experience of 2016 survey respondents during their postdoctoral training. Symptoms were experienced for more than a month at a time.

**Figure 7.** Percentage of satisfaction across various elements of the postdoctoral training. Satisfaction levels range from high (left side of bars) to low (right side of bars). Data was only collected from 2016 CAPS-ACSP Canadian National Postdoctoral Survey.

**Figure 8.** Structural equation model with significant predictors of postdoctoral training satisfaction. Latent constructs are oval-shaped, while directly measured single-indicator constructs are indicated by rectangle-shaped variables. Only the indicators with significant loadings (.60 or greater) were retained for each final measurement model. Not shown are the direct and mediating paths from predictors to the mental health construct; however, as indicated by Figures 5 and 9, these mediating effects were tested for variety of skills training, encouragement from supervisor, non-academic career preparation, and salary.

**Figure 9.** Relative effects (Cohen’s $f^2$) of predictors of postdoc satisfaction. Bars indicate the strength of the relationship of the predictors on y-axis with the two satisfaction constructs, compensation and career training, and with mental health.