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The Status of Women Cognitive Scientists in Canada: Insights From Publicly Available NSERC Funding Data

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A crucial question within science and academia, and cognitive science specifically, is whether there is gender disparity in opportunity and advancement over the professional life span (e.g., Ceci, Ginther, Kahn, & Williams, 2014; Geraci, Balsis, & Busch, 2015; Valian, 1998). To investigate this question, we analyzed gender distributions in publicly available federal funding data from the Natural Sciences and Engineering Research Council (NSERC) of Canada that are specific to cognitive psychology and cognitive neuroscience. There were three key results. First, the proportion of women cognitive scientists progressively diminished at each career stage, particularly at the transition between graduate and postdoctoral studies. Second, female principal investigators (PI) received smaller average Discovery Grant amounts and were less likely to receive Discovery Accelerator Supplements as a proportion of all Discovery Grants funded. Finally, at the PI level, gender differences were relatively smaller for institution-initiated grants (i.e., Canada Research Chairs) versus investigator-initiated grants (i.e., Discovery Grants). It is our hope that presentation of such data, in concert with other recent reports for our field (e.g., Klatzky, Holt, & Behrmann, 2015; Peelle, 2016; Vaid & Geraci, 2016), continues to raise awareness that gender parity issues remain a concern that deserves ongoing attention within the field of cognitive science in Canada.

Public Significance Statement
Using publicly available NSERC funding data, this study shows evidence of a "leaky pipeline" for women scientists within Canadian cognitive science. There are more NSERC-funded women than men undergraduate and graduate students over the past several years, however, at the postdoctoral stage and independent investigator stage, there are fewer women than men for the same timeframe. Moreover, at the independent investigator stage, average grant amounts were lower for women, and women were less likely to receive special supplemental amounts for their grants. Gender effects were reduced for institution-initiated versus investigator-initiated grants.

Keywords: gender in science, cognitive psychology, professional issues, funding data, leaky pipeline

An important question for modern cognitive science is whether there is gender disparity in opportunity and advancement over the professional life span (Ceci et al., 2014; Geraci et al., 2015; Valian, 1998). Certainly, attitudes about women's career roles in STEM (i.e., science, technology, engineering, & medicine), and educational/career trajectories have evolved compared to generations past (Cundiff, 2012). Such improvements have occasionally sparked doubts as to whether a gender parity problem still exists (e.g., Ceci et al., 2014), a sentiment that is potentially exacerbated by notions of academic meritocracy, and limited awareness about

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The data are available at https://osf.io/sr9f4/
The experiment materials are available at https://osf.io/sr9f4/.

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the influence of implicit gender schemas on everyday behavior (Valian, 1998). However, varied sources of evidence indicate that academia has not attained gender parity (Cundiff, 2012, Hill, Corbett, & St Rose, 2010; Duch et al., 2012; Kite et al., 2001; Morawski & Agronick, 1991), even within disciplines viewed as "feminized," such as psychology (e.g., Vaid & Geraci, 2016). These sources include data on hiring and salary, lab space allocation, service demands, teaching evaluations, and other objective signifiers of academic success (see annotated bibliography of Savonic & Davidson, 2017). Thus, for reasons both historic and current, women occupy fewer positions of leadership or distinction than men, despite making up half or more of bachelor's degree recipients in cognitive psychology (Monroe & Chiu, 2010; Vaid & Geraci, 2016). This situation is potentially more concerning for women who have other intersecting aspects of their identity (e.g., race, class, ethnicity, sexuality, and disability; Gonzales, Blanton, & Williams, 2002; Johnson, 2007; Savonic & Davidson, 2017).

Attrition of women from academia at consecutive professional stages (the "leaky pipeline" or "vanish box") arguably results from, and contributes to a system that underrepresents and fails to recognize women's accomplishments (Etzkowitz & Ranga, 2011; Monroe & Chiu, 2010; Shields, 1975; Vaid & Geraci, 2016). As a consequence, an absence of women at the top iteratively impacts women who are beginning their academic careers and looking for senior role models and mentorship opportunities (Rosser, 2014; Sanders, Willemsen, & Millar, 2009).

Evidence of a leaky pipeline has catalyzed calls to action globally such as Science Minister Kirsty Duncan's campaign to increase the representation of women within Canadian Science at its highest levels (Rabson, 2017). For example, Minister Duncan has expressed concerns that approximately 30% of Canada Research Chairs (CRC) recipients (a program intended to boost recruitment and retention of the brightest and best Canadian academics) have gone to women over the program's lifetime of 16 years. She consequently proposed policy changes aimed at increasing diversity (e.g., recently introducing renewal limits for senior CRC positions to increase turnover), which have occasionally been countered in the popular press by the argument that policy remediation conflicts with the tenets of a "fair" meritocratic society.

Along these lines, a recent Montreal Gazette editorial argued that any policy-based step to address gender parity "undermines true meritocracy", and "demonstrates that they [the government] care more about the identities of those being awarded the position than they do applicants' track records and the impact factor of their research—of which scientists are constantly fixated" (Nykyforiak, 2017). However, missing from this argument is that universities carefully curate who is nominated for CRC opportunities (a point to which we later return). Thus, the percentage of women "applicants" is not necessarily applicant-driven, nor is the self-selection of women for other applicant-driven positions independent of structural issues within academia.

Indeed, confusion can arise when investigating the nuanced notion of gender parity within academia, an issue that we believe can only be remedied by greater availability of objective, transparent, and carefully interpreted data on the subject. To this end, we examined leaky pipeline concerns using publicly available funding data within our own fields, cognitive psychology and cognitive neuroscience, which have recently received attention in this regard (e.g., Klatzky et al., 2015; Peelle, 2016; Vaid & Geraci, 2016). Here, we operationalize the leaky pipeline metaphor as reflecting the presumed shift from a large number of women undergraduate degree recipients in psychology, to a relatively smaller number of graduate students and postdocs, to an even smaller number of early career professors and senior professors.

With respect to the leaky pipeline, most evidence of gender imbalance has traditionally relied on a patchwork of data sources, examining individual snapshots along the professional life span, without full contiguity across the various stages in one academic ecosystem. As Canadian cognitive psychologists, we have the unique opportunity to conduct more comprehensive analyses on the allocation of federal funding from agencies like the Natural Sciences and Engineering Research Council (NSERC), which vitally supports a large proportion of cognitive science research over the entire professional life span, ranging from the undergraduate to senior career stages. As well, the distribution of federal funding may be somewhat more immune to interpersonal factors that can impact the hiring of faculty (Moss-Racusin, Dovidio, Brescoll, Graham, & Handelsman, 2012; Reuben, Sapienza, & Zingales, 2014, although see Witteman, Hendricks, Straus, & Tannenbaum, 2017).

Thus, the present paper offers an analysis of gender distributions in publicly available federal funding data from NSERC that are specific to cognitive psychology/neuroscience. To the extent that the leaky pipeline metaphor applies to women in cognitive science within Canada, we would expect the proportion of women to men who receive NSERC funding at different professional stages to progressively diminish over the professional life span.

Method

We used the searchable NSERC Award Database (http://www.nserc-crsng.gc.ca/ase-oro/index_eng.asp). This database provides the names and award details (funds awarded, subject area, grant titles) of successful applicants to all NSERC programs. We analyzed NSERC undergraduate student awards, graduate student awards, postdoctoral awards, Discovery Grants, Discovery Accelerator Supplements, and the Canada Research Chairs program. To limit our analyses to cognitive psychology/neuroscience in the past several years, we took the following steps. First, we restricted the analysis window to the past 7 years for all programs (2009–2016), except for the Canada Research Chairs Awards for which we analyzed the program's lifetime (2001–2016). We also restricted the subject search to: behavioral neuroscience, behavioral neuroscience (learning), behavioral neuroscience (reward, motivation), cognitive science (development), cognitive science (fundamental), cognitive science (language), cognitive science (other), motor systems and performance, psychology, sensory systems (auditory), sensory systems (visual), sensory systems and perception. We included all grants awarded in each year, and did not correct for multiyear awards. Thus, if a particular researcher received a 3-year grant in 2010, their data were included across the averages for 2010, 2011, and 2012. All de-identified data used in our analyses are available through the Open Science Foundation project (*osf.io/sr9f4*).

To classify applicant gender, we used the R package "gender" (Mullen, 2015). This package uses historical names databases to calculate the proportion of female and the proportion of male with each first name. We hand checked all outputs for accuracy, and

conducted follow-ups to find online profiles or websites to confirm applicant gender based on self-presentation and pronoun use when the package could not calculate a gender likelihood for a name, or if the proportions of female and male was close to equal for a name. In the overwhelming majority of cases, gender could be identified using these methods. In total, we excluded only 21 individuals (19 undergraduate applicants and 2 graduate applicants) out of our entire set of 7,134 observations. These methods did not account for nonbinary or gender fluid individuals.

Results

Undergraduate, Postgraduate, and Postdoctoral Awards

Student NSERC funding supports undergraduate summer research experiences, graduate fellowships at the masters and doctoral levels between 1 and 3 years, and postdoctoral fellowships for 1 to 2 years. Figure 1 presents the number of awards for our field as a function of gender at the undergraduate (USRA; left panel), graduate (middle panel, all programs combined), and postdoctoral (right panel, all programs combined) levels. Although one could argue that sample statistics are unnecessary as we present data for the entire population of award recipients for our field over these years, we performed a chi-square test of goodness-of-fit, collapsed across all years, to assess whether females (solid) and males (dashed) equally received NSERC awards at each student or trainee level. All chi-squared analyses rendered significant results: Females and males did not equally receive the Undergraduate awards, $\chi^2(2, N = 1524) = 82.23$, $p < .05$, the Graduate awards, $\chi^2(2, N = 1641) = 83.43$, $p < .05$, or the Postdoctoral awards, $\chi^2(2, N = 150) = 3.84$, $p < .05$. In sum, women obtained significantly more undergraduate and graduate awards, but significantly *fewer* postdoctoral awards. Moreover, it appears from Figure 1 that the ratio of women to men in number of Graduate and Postdoctoral Awards may have diminished over time, a point to which we return in the General Discussion.

Discovery Grants and Accelerator Supplements

Discovery Grants to principal investigators are the lifeblood of Canadian curiosity-driven science, particularly within our field. These grants are usually 5 years in duration and are said to fund research programs rather than research projects. Within cognitive psychology and cognitive neuroscience, principal investigators commonly apply for, and obtain, an initial Discovery Grant in their first year or two as faculty, and if they continue to be productive (i.e., to publish and train students, etc.), it is likely that they will continue to be funded every five years over the duration of their careers. At NSERC, the philosophy is to give moderate sized funding amounts to as many qualified researchers as possible. Accordingly, Discovery Grant amounts are largely a function of how a given grant is evaluated within any application cycle rather than the actual budget requested.

Figure 2 presents, for our field, the number of Discovery Grants awarded (left panel), the average grant amount (middle panel), and

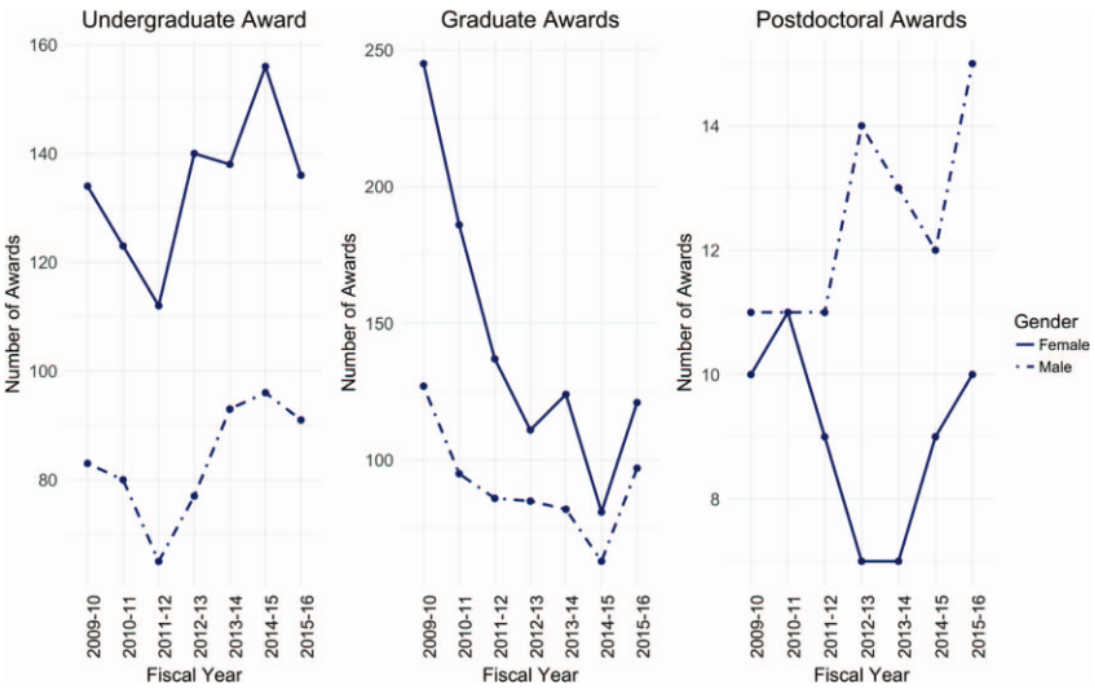

Figure 1. Number of awards granted for each student or trainee program. Left: Undergraduate Student Research Awards to undergraduates. Middle: Alexander Graham Bell Graduate, Postgraduate, and Vanier Awards to graduate students. Right: Postdoctoral and Banting Awards to postdoctoral trainees. See the online article for the color version of this figure.

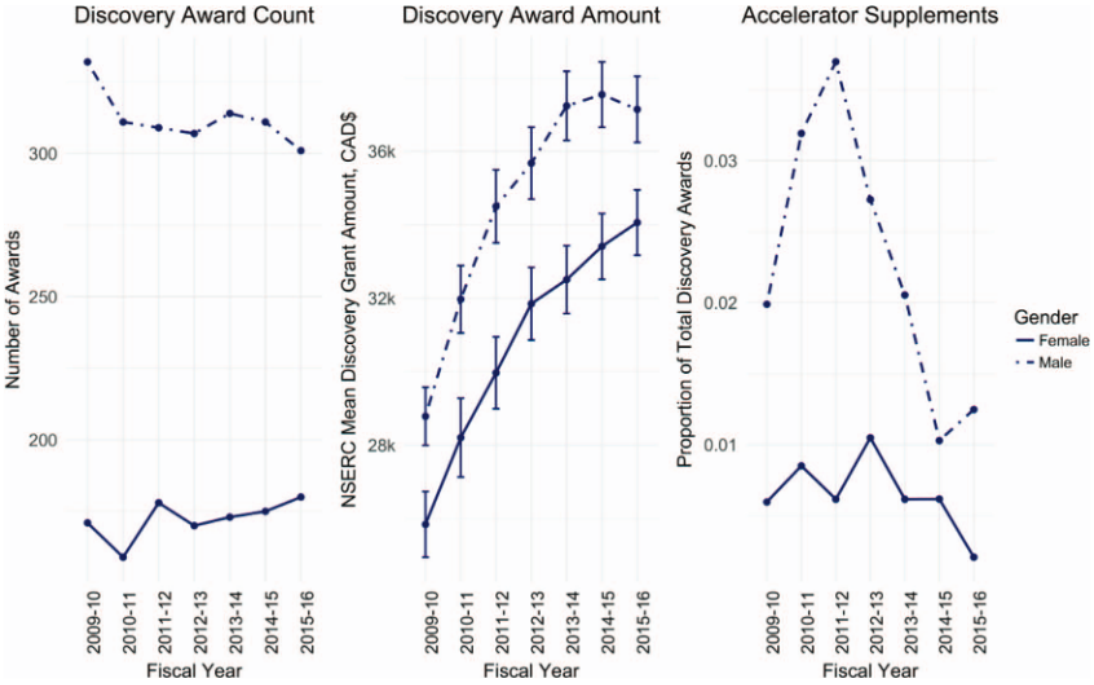

Figure 2. Left: Number of Discovery Grants awarded from 2009–2016. Middle: Mean Discovery Grant amount awarded by gender with plus or minus one standard error of the mean. Right: Accelerator Supplements awarded by gender as a proportion of all Discovery Grants for each year. See the online article for the color version of this figure.

the proportion of awarded Discovery Grants that earned an "Accelerator Supplement" (awarded to applicants who show strong potential, and who are judged to have bold innovative research programs; right panel). Again, despite the fact that we present population rather than sample data and can thus interpret the counts directly, a chi-square test of goodness-of-fit revealed that women and men did not equally receive Discovery Grants, collapsed over all years, $\chi^2(2, N = 3391) = 282.64$, $p < .05$. An independent samples t test revealed that females ($M = \$30{,}891.63$) and males ($M = \$34{,}628.63$) also significantly differ in the mean Discovery Grant amount, collapsed over all years; $t(3034.5) = -7.36$, $p < .05$. Finally, a chi-squared goodness-of-fit test revealed that women and men did not equally receive the Accelerator Supplements, collapsed over all years, $\chi^2(2, N = 99) = 30.56$, $p < .05$. Thus, women obtained significantly fewer Discovery Grants, had lower average awarded grant amounts, and were less likely to obtain Accelerator Supplements as a proportion of all Discovery Grants awarded within each year.

Canada Research Chair (CRC) Awards

The CRC program was introduced in 2001 to attract and retain leading researchers at Canadian academic institutions. They are institution-initiated grants intended for a named applicant. The senior Tier 1 CRCs are $200,000/year for 5 years, renewable indefinitely, and the junior Tier 2 CRCs are $100,000/year for 5 years, renewable only once (though the Canadian government has recently introduced term limits for senior Tier 1 CRCs going forward). The funding amounts are variably distributed within and across institutions, and are often a point of policy or negotiation within an institution. The bulk of each award generally defrays institutional salary costs for the named researcher in a manner that saves the institution resources, and individual researchers may also receive yearly research and salary stipends depending on how successfully they negotiated a particular package with their university or their department, or as a function of set policies within universities or departments.

Figure 3 presents population data for our field of the number of CRC awards at the senior Tier 1 level (Figure 3, left panel), at the junior Tier 2 level (middle panel), and collapsed over Tier 1 and 2 levels (right panel). Chi-square goodness-of-fit tests did not reveal a significant difference between females and males for Tier 1, $\chi^2(2, N = 113) = 2.56$, $p = .11$, or Tier 2 CRC, $\chi^2(2, N = 217) = 1.33$, $p = .25$. However, collapsed over all CRCs, the chi-squared goodness-of-fit test trended toward significance, $\chi^2(2, N = 330) = 3.50$, $p = .061$. In sum, compared to Discovery Grants and Accelerator Supplements, there was only weak evidence that women obtained fewer NSERC CRCs than men in the selected subject areas when collapsed over Tier 1 and 2 CRCs.

Discussion

In this paper, we analyzed the gender distribution of funding within a specific academic ecosystem, that is, within one subdiscipline (i.e., cognitive psychology/neuroscience), one period of time (i.e., past 7 years), and one nation (i.e., Canada). We discuss our main findings below.

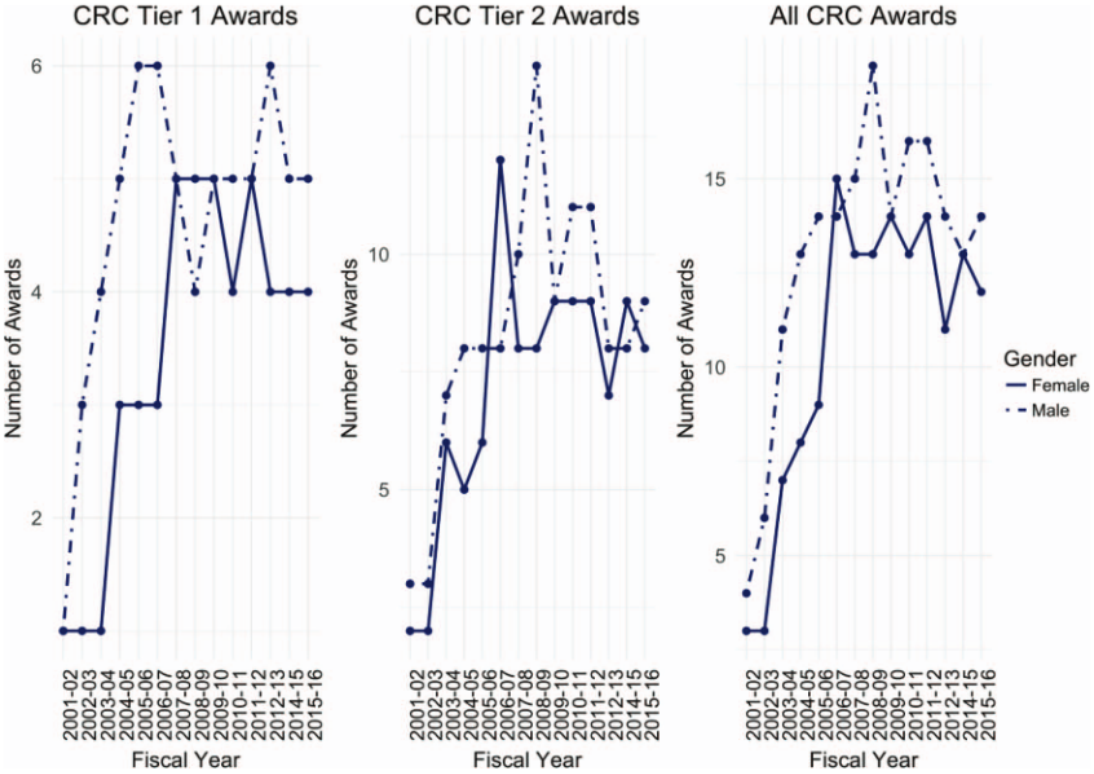

Figure 3. Canada Research Chairs granted between 2001 and 2016. Left: Tier 1 CRC typically go to senior researchers who receive $200k/year. Middle: Tier 2 CRC are typically junior researchers and receive $100k/year. Right: All CRC recipients. See the online article for the color version of this figure.

Student Funding Data: The Pipeline Leaks Precipitously at the Postdoctoral Stage

At the undergraduate level, which arguably constitutes the baseline number of women and men entering the "pipeline" of our field, significantly more women than men were awarded NSERC funding to obtain a summer research experience, collapsed over the past 7 years. This is consistent with the standard view that women outnumber men in terms of psychology and cognitive science majors at the undergraduate level. Inspection of Figure 1, which depicts NSERC undergraduate research awards as a function of fiscal year, suggests that the magnitude of the gender difference was relatively stable over the past 7 years, although the total number of awards fluctuated. See also, Figure 4, which depicts the women to men funding ratio across all fiscal years that we evaluated, for each program.

Similarly, at the graduate student level, significantly more women than men graduate students were awarded NSERC scholarship funding overall. Of note, any female advantage in graduate student funding within cognitive science/neuroscience directly follows from the higher likelihood of female undergraduate majors in our field. However, inspection of Figures 1 and 4 suggests that the magnitude of the gender difference that advantaged women varied over the past 7 years, in that a female advantage was maximal in the first 3 fiscal years encompassing 2009–2012, compared to the past 4 fiscal years encompassing 2012–2016, where it appeared to be reduced. Of note, this potential difference over time did not match any changes happening at the undergraduate level.

At the very next career stage, significantly fewer women postdoctoral researchers were awarded NSERC funding. Here, inspection of Figures 2 and 4 suggests that gender differences changed over time, in that they were minimal in the first two fiscal years spanning 2009–2011, but were maximal in the past five fiscal years spanning 2011–2016, in a manner that disadvantaged women in later years (similar to graduate student awards). These data raise the possibility that a decreasing number of women funded at the graduate level (which reflects a consistently higher base rate of women over men among psychology/cognitive science majors) may be linked to the decreased number of women at the postdoctoral level over the same period of time. It is conceivable that a decreasing proportion of women obtaining NSERC graduate and postdoctoral awards over the past several years may be linked to the decreased proportion of new academic hires within top tier academic institutions in Canada who are women, which was 46.7% in 2006–2011 and dropped to 35.3% in 2012–2016 (Pennycook & Thompson, 2018).

Women Obtain Fewer Discovery Grants, Lower Grant Amounts, and a Smaller Proportion of Accelerator Supplements

Consistent with the trend emerging at the postdoctoral level, fewer women than men obtained Discovery Grants, their average

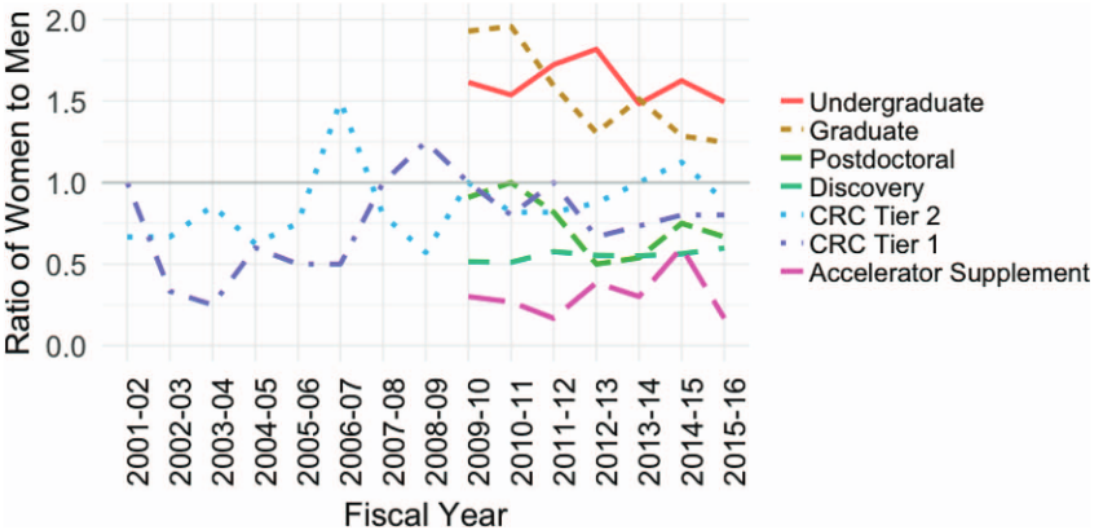

Figure 4. The ratio of women to men in number of grants awarded at each career stage for the fiscal years evaluated in this paper at each career stage. Values greater than 1 indicate a larger proportion of women to men; values less than 1 indicate a smaller proportion of women to men; values equal to 1 indicate gender parity. See the online article for the color version of this figure.

grant amount was smaller, and as a percentage of funded Discovery Grant awards, women obtained fewer Accelerator Supplements than men. Recall, the Discovery Grant is the lifeblood of cognitive science/neuroscience researchers within Canada. Thus, an absence of gender parity at this level directly translates to reduced capacity in terms of a researcher's ability to pay for student research assistants, participant compensation, research equipment, conference costs, or to engage in high-profile but costly research activities (e.g., collecting neuroimaging data). To the extent that women researchers are less likely to obtain Discovery Grant funding, or receive smaller funding amounts, their short term research prospects will be negatively impacted, which could later cascade to produce even greater gender differences in subsequent stages of their career (see also Frederickson, 2018, for public data from Ontario showing that NSERC funding amounts do not mitigate lower faculty salaries for women).

It is possible that gender differences in Discovery Grant amounts arise in part because women request lower funding amounts than men. We do not have access to those data; however, we speculate that such an effect would have minimal impact given that Discovery Grant funding amounts are tied to the quality bin assigned to each application during the evaluation process rather than to the funds requested. To illustrate, imagine a hypothetical applicant who requested a yearly budget of $50k/year. If this applicant was evaluated as "Strong" they might only be awarded $25k/year because this is the amount assigned to the "Strong" bin, irrespective of the $50k/year budget requested; if this applicant was evaluated as "Outstanding" they may fall into a quality bin that matches their requested budget; if this applicant was evaluated as "Exceptional" they would not get more than $50k/year even if that quality bin was associated with greater funding (e.g., $80k/year). Thus, for the most highly ranked "exceptional" grants, it is possible that women may have requested less than what their quality bin would allow, however, very few researchers likely fall into this elite category.

Similarly, we found that the percentage of Discovery Grant Accelerator Supplements, which provide researchers with an extra $120,000 over 3 years on top of their base Discovery Grant award amount, was lower for women than men. Of note, the decision to award a particular applicant an Accelerator Supplement is initiated by individual members of the evaluation committee, thus, there is no applicant-driven behavior that factors into this decision. Also of note, while NSERC proactively strives for their evaluation process to be as gender-neutral as possible (e.g., instructing reviewers that all discussions of applicants should use gender-neutral language, providing training on issues pertaining to bias in advance of the review process), the evaluation process for any peer-reviewed granting mechanism is never fully blind. Thus, to the extent that bias can creep into this process (for both female and male evaluators, e.g., Moss-Racusin et al., 2012), and women are less likely to have the opportunity to capitalize on such transformative career opportunities, this could very easily lay the groundwork for even greater gender disparities than already exist at the midcareer and senior end of the professional life span.

Another question raised by these data is whether gender differences vary over different topics of research within cognitive science in Canada. For example, in their analysis of the Canadian academic job market in our field, Pennycook and Thompson, 2018 found that the largest group of new hires between 2006 and 2016 to tenure track faculty positions in top tier institutions in Canada was comprised of male neuroscientists (35%). This was by far the largest percentage of any group, followed by female neuroscientists and male or female behavioral-only cognitive scientists (approximately 20% in each category). Within the NSERC funding data presented here, a variety of research areas were represented, including neuroscience, developmental, and cognitive grants. To

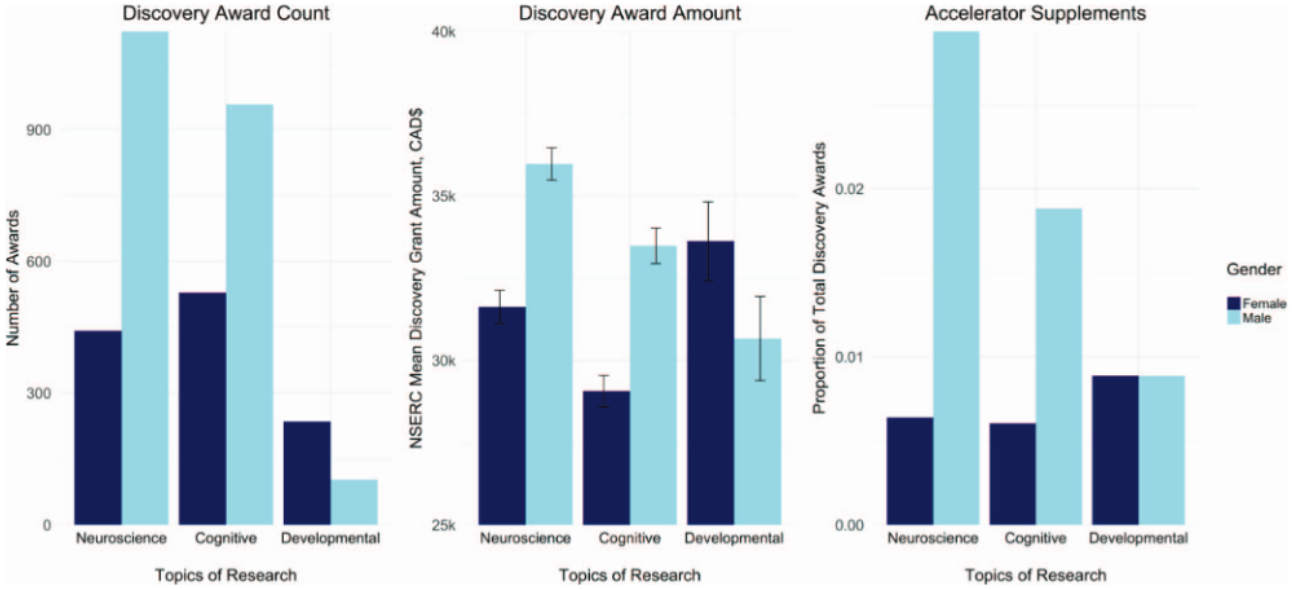

Figure 5. Left: Number of Discovery Grants awarded from 2009–2016 as a function of gender and research topic. Middle: Mean Discovery Grant amount awarded as a function of gender and research topic, with plus or minus one standard error of the mean. Right: Accelerator Supplements as a proportion of all Discovery Grants for each year as a function of gender and research topic. See the online article for the color version of this figure.

assess whether gender differences held constant over these research topics, we performed a series of keyword searches (keywords available through the Open Science Foundation project, *osf.io/sr9f4*) on Discovery Grant titles to semiautomatically sort awards into these three groups. We first devised a set of keywords to sort neuroscience grants from all other grants (brain, neural, etc.), along with a new set of keywords to sort developmental grants from the remaining grants (education, baby, children etc.), and then simply designated all remaining unsorted grants as "cognitive."

Figure 5 presents gender differences as a function of topic of research, collapsed over years, for Discovery Grant counts, Discovery Grant average amounts, and proportion of Accelerator Supplements. As can be seen in Figure 5, from 2009 – 2016, women obtained relatively fewer neuroscience Discovery Grants and Accelerator Supplements than men compared to cognitive grants, although the average grant amounts were similar. Interestingly, however, the pattern shifted dramatically for developmental grants. Here, the ratio of women to men in number of awards was more favorable to women, as was the average funding amount. Further, there was no difference in the proportion of Accelerator Supplements awarded to women and men on developmental topics, which given the base rate of more grants overall to women than men, constituted a relative advantage to men. Thus, it appears that subfields of cognitive science are differentially gendered in a manner that conforms to stereotypical gender role expectations (i.e., women are relatively less likely to participate in the "hard" neurosciences and more likely to participate in developmental fields emphasizing "nurturing"). Even in the developmental field, however, it could be argued that women are proportionally less likely to benefit from special distinctions, such as Accelerator Supplements. Thus, participation in gender-consistent fields (i.e., development) appears to buffer against the disadvantage that women face in overall award amounts. Of course, the grant data for the development topics are based on very small numbers of applications and so those results should be interpreted with caution.

Gender Differences Are Less Pronounced for Institution-Initiated CRC Awards Than for Applicant-Initiated Discovery Grants

Interestingly, gender differences were less apparent when we analyzed CRC awards data for our field. When the number of all CRC awards was considered, there was a nonsignificant trend for men to outnumber women, however, there were no reliable differences when we analyzed the Tier 1 (senior) or Tier 2 (junior) CRCs individually (though again, given that we evaluated the entire population of grant recipients, a case could be made that statistics are unnecessary for interpreting raw counts). There are multiple reasons why the gender differences may have been less striking for the CRC awards compared to Discovery Grants, even though they draw from the same pool of applicants at any given point in time. First, the relatively fewer CRC awards we had to analyze may not afford sufficient statistical power for us to detect a small or moderate effect of gender. Consistent with this view are reports that across the entire CRC program, awards to men far exceeded those to women (70 vs. 30%), as noted in Minister Duncan's public comments mentioned above.

Second, CRCs are typically institution-initiated to promote faculty hiring or retention, the former of which (i.e., hiring) is highly formalized usually having clearer guidelines regarding gender representation, whereas the latter (i.e., retention) is highly opaque and even idiosyncratic across departments and institutions, with

few formal guidelines. Indeed, many high quality researchers may go their entire careers without presenting a retention threat to their institutions, whereas at the other extreme, some researchers may regularly seek out competing offers, a difference which may itself be systematically related to gender. To investigate these issues further, it would be useful to have access to CRC award data (within our field or across all fields) broken out by whether a given CRC was awarded for the purpose of recruitment versus retention.

Third, our analysis of CRC award counts may be insufficient for detecting more hidden effects relating to how CRC awards are dispensed to institutions versus awardees. For example, we cannot determine how beneficial a CRC is to an individual researcher in terms of greater or lower salary stipends or research funding stipends. Such differences in how funds are allocated may vary across departments within an institution, although it is likely that over the lifetime of the program, institutions may have established more standardized guidelines for how the funds are used. To the extent that standardization of award dispensation is not the norm, and the provision of salary or research stipends are at institutional or departmental discretion or the negotiating prowess of individual awardees, the likelihood of gender disparities disadvantaging women scientists would presumably increase.

Finally, the overall success rate of NSERC Discovery Grants is 67%, whereas the overall success rate of CRCs is over 98%. Again, this highlights that institutions initiate the CRC application process for a small, hand-selected number of individuals and this leads to an almost perfect match between the number of submitted and awarded applications. In contrast, the number of submitted applications by definition exceeds the number of awarded applications for the Discovery Grants, given a 67% success rate. This leads to an additional concern (similar to that raised by the Montreal Gazette editorialist mentioned in the introduction) that gender differences arise simply because men apply for investigator-initiated grants (or other opportunities) more often than women, and that if one were to compute success rates (i.e., the number of funded awards divided by the number of submitted awards), gender differences would disappear.

Unfortunately, success rate data are unavailable from the public NSERC database (also unavailable are data pertaining to academic rank, which may play an important role). Interestingly, when NSERC does report success rates broken out by gender (e.g., presented at information meetings, online), often they show very little by way of gender differences. However, crucial here is that a substantial number of people who apply for NSERC awards (approximately one third) fail to self-report gender to NSERC, a fact that NSERC fully acknowledges and wishes to remedy. Applicants may omit gender information for any number of reasons, such as having a gender fluid identity. However, applicants may also fail to self-report gender for reasons that systematically relate to ultimate funding outcomes (e.g., women applicants fearing they may be subjected to bias, or male applicants fearing rejection from institutions trying to fill diversity quotas.) Thus, the interpretation of officially released success rates for women and men is challenging at best in the context of such a large proportion of missing data.

Without clear data about true success rates, critics channeling the Montreal Gazette editorial described earlier will likely continue to suggest that any indication of gender disparity is researcher-driven (i.e., women-driven), either because of limitations in competency (recall, the infamous Google memo questioning women in technology, https://en.wikipedia.org/wiki/Google%27s_Ideological_Echo_Chamber), or gumption (i.e., that women scientists are not as serious as men). Setting aside the caveats that such arguments do not necessarily apply to CRC awards data (which are less applicant-driven), or to average Discovery Grant award amounts, or the percentage of all funded Discovery Grants receiving an Accelerator Supplement, it is possible that the leaky pipeline partially arises because women scientists actively remove themselves from the pipeline over the professional life span. However, to the extent that this is even partially true, it remains essential to better understand the forces that cause women to do this, particularly given a baseline within our own field where there are substantially more funded women undergraduate and graduate students in the pipeline to start.

Gender Concerns within Cognitive Science More Broadly

Dovetailing with the situation in Canada is recent work for our field at large. For example, Vaid and Geraci (2016) investigated the representation and recognition of senior women cognitive psychologists by measuring the number of women journal editors and recipients of prestigious research awards. Similarly, a recent special issue of the prestigious journal *Cognition*, entitled "the Changing Face of *Cognition*" (February 2015), included 12 curated articles by 19 authors, of which only one author (a student coauthor) was female. In response, Klatzky et al. (2015), three senior women cognitive psychologists, wrote a letter stating, "While the substantive content of the issue may persuade us that the face of cognition is changing, it appears that changes in gender distribution are not to be expected." To the journal's credit, this letter was rapidly published along with an editorial response stating, "I also agree that the most recent special issue did not include an adequate representation of women . . . the question remains what an appropriate proportion of women should be for our special issues." Similar issues have arisen with respect to other aspects of professional success and visibility such as conference presenters, keynote and invited colloquia speakers within our field (e.g., Henderson, 2015; Nittrouer et al., 2018; Peelle, 2016), suggesting that the visibility of women in positions of leadership and influence continues to lag well behind that of men (Lerback & Hanson, 2017; Mandavilli, 2016). Importantly, the NSERC funding data we report here for our field within Canada suggest that what is considered an appropriate proportion of women could vary dramatically as a function of the stage of professional development one considers—the proportion of women entering the professional pipeline or the proportion of women surviving in the pipeline at the principal investigator stage.

This leads to larger questions about whether other forms of gender bias disadvantage women of childbearing age, create occupational demands that conflict with family care demands of both children or elders (which often disproportionately fall upon women), and make it more likely that women follow their partner's career. There are also questions about similar forces occurring for women who defy the odds to obtain tenure track faculty positions, such as greater service expectations (Guarino & Borden, 2017), biased course evaluations (Boring, 2017; MacNell, Driscoll, & Hunt, 2015), reduced mobility in confer-

ence travel due to family expectations, constraints on effective negotiation approaches, research self-promotion (Maliniak, Powers, & Walter, 2013), and the list goes on. Thus, it is possible that the masculine and rigid structure of academia has not caught up with progressive social movements of diversity and inclusion, and thus it demands more work from women to reach a level playing field with their male colleagues.

Concluding Remarks

In this paper, we empirically evaluated the leaky pipeline metaphor in the field of cognitive science for NSERC-funded individuals over the professional life span. We found that for our particular academic ecosystem within Canadian cognitive science, there is a substantial leakage of women scientists that begins at the postdoctoral level and continues through the independent investigator level. It is our hope that presentation of such data, in concert with other reports for our field (e.g., Klatzky et al., 2015; Peelle, 2016; Vaid & Geraci, 2016) continues to raise awareness that gender parity issues deserve further attention and redress within the field of cognitive science in Canada. We thus advocate for fundamental paradigm shifts in understanding gender and minorities through grassroots efforts in bringing awareness to this issue (see Women in Cognitive Science, http://womenincogsci.org; Women in Cognitive Science-Canada, https://www.csbbcs.org/wics), and conducting research on effective strategies against implicit bias alongside active measures toward equity by powerful institutions and organizations (e.g., Parker, Monteith, Moss-Racusin, & Van Camp, 2018). We are especially encouraged that funding agencies like NSERC have seriously incorporated these concerns into the fabric of the grant review and evaluation process. Such important proactive measures emphasize that strong leadership of this sort will impact how academic institutions and individual researchers shape policies that are crucial to success over the academic life span for all cognitive scientists, and to the overall health of our discipline.

Résumé

Une question cruciale au sein de la science et du milieu universitaire, et la science cognitive spécifiquement, est de savoir si il ya genre disparité de chances et d'avancement sur la durée de vie professionnelle (p. ex. ceci, Ginther, Kahn, & Williams, 2014; Geraci, Balsis, & Busch, 2015; Crovax, 1998). Pour enquêter sur cette question, nous avons analysé répartition des sexes dans les données du financement fédéral des sciences naturelles et du genie Conseil de recherches du Canada (CRSNG) qui sont spécifiques à la psychologie cognitive et aux neurosciences cognitives. Il y a eu trois résultats clés. Premièrement, la proportion de femmes scientifiques cognitives a progressivement diminué à chaque étape de carrière, en particulier lors de la transition entre les études supérieures et postdoctorales. Deuxièmement, les femmes les chercheurs principaux (pi) ont reçu des subventions de découverte moyenne moindres et étaient moins susceptibles de recevoir Discovery Accelerator suppléments en proportion de toutes les subventions de découverte financées. Enfin, au niveau pi, les différences entre les sexes étaient relativement moindres pour les subventions engagées par les institutions (c.-à-d. les chaires de recherche du Canada) versus subventions initiées par les chercheurs (c.-à-d. subventions de découverte). Nous espérons que la présentation de ces données, de concert avec d'autres rapports récents pour notre domaine (p. ex., Klatzky, Holt, & Behrmann, 2015; Peelle, 2016; Vaid & Geraci, 2016), continue de sensibiliser le public à la question de la parité entre les sexes qui mérite une attention soutenue dans le domaine des sciences cognitives au Canada.

Mots-clés : sexe en sciences, psychologie cognitive, questions professionnelles, données de financement, pipeline perméable.

References

Boring, A. (2017). Gender biases in student evaluations of teaching. *Journal of Public Economics, 145,* 27–41. http://dx.doi.org/10.1016/j.jpubeco.2016.11.006

Ceci, S. J., Ginther, D. K., Kahn, S., & Williams, W. M. (2014). Women in academic science: A changing landscape. *Psychological Science in the Public Interest, 15,* 75–141. http://dx.doi.org/10.1177/1529100614541236

Cundiff, J. L. (2012). Is mainstream psychological research "womanless" and "raceless"? An updated analysis. *Sex Roles, 67,* 158–173. http://dx.doi.org/10.1007/s11199-012-0141-7

Duch, J., Zeng, X. H. T., Sales-Pardo, M., Radicchi, F., Otis, S., Woodruff, T. K., & Nunes Amaral, L. A. (2012). The possible role of resource requirements and academic career-choice risk on gender differences in publication rate and impact. *PLoS ONE, 7,* e51332. http://dx.doi.org/10.1371/journal.pone.0051332

Etzkowitz, H., & Ranga, M. (2011). Gender dynamics in science and technology: From the "leaky pipeline" to the "vanish box." *Business and Economic Review, 54,* 131–148.

Frederickson, M. (2018). Canadian female professors still face a gender pay gap. *The Conversation*. Retrieved from http://theconversation.com/canadian-professors-still-face-a-gender-pay-gap-93609

Geraci, L., Balsis, S., & Busch, A. J. (2015). Gender and the h index in psychology. *Scientometrics, 105,* 2023–2034. http://dx.doi.org/10.1007/s11192-015-1757-5

Gonzales, P., Blanton, H., & Williams, J. (2002). The effects of stereotype threat and double-minority status on the test performance of Latino women. *Personality and Social Psychology Bulletin, 28,* 659–670. http://dx.doi.org/10.1177/0146167202288010

Guarino, C. M., & Borden, V. M. H. (2017). Faculty service loads and gender: Are women taking care of the academic family? *Research in Higher Education, 58,* 672–694. http://dx.doi.org/10.1007/s11162-017-9454-2

Henderson, J. (2015, August 17). *Why I won't be at ECEM Pt. 1*. Retrieved from http://whoeverfightsmonsters.wordpress.com/author/mindsee

Hill, C., Corbett, C., & St Rose, A. (2010). *Why So Few? Women in Science, Technology, Engineering, and Mathematics*. Washington, DC: American Association of University Women.

Johnson, A. C. (2007). Unintended consequences: How science professors discourage women of color. *Science Education, 91,* 805–821. http://dx.doi.org/10.1002/sce.20208

Kite, M. E., Russo, N. F., Brehm, S. S., Fouad, N. A., Hall, C. C., Hyde, J. S., & Keita, G. P. (2001). Women psychologists in academe. Mixed progress, unwarranted complacency. *American Psychologist, 56,* 1080–1098. http://dx.doi.org/10.1037/0003-066X.56.12.1080

Klatzky, R. L., Holt, L., & Behrmann, M. (2015). The representation of women in cognition. *Cognition, 141,* 170–171. http://dx.doi.org/10.1016/j.cognition.2015.03.010

Lerback, J., & Hanson, B. (2017). Journals invite too few women to referee. *Nature, 541,* 455–457. http://dx.doi.org/10.1038/541455a

MacNell, L., Driscoll, A., & Hunt, A. N. (2015). What's in a name: Exposing gender bias in student ratings of teaching. *Innovative Higher Education, 40,* 291–303. http://dx.doi.org/10.1007/s10755-014-9313-4

Maliniak, D., Powers, R., & Walter, B. F. (2013). The gender citation gap in International Relations. *International Organization, 67,* 889–922. http://dx.doi.org/10.1017/S0020818313000209

Mandavilli, A. (2016, September 5). Female scientists turn to data to fight lack of representation on panels. *The New York Times*. Retrieved from http://www.nytimes.com

Monroe, K. R., & Chiu, W. F. (2010). Gender equality in the academy: The pipeline problem. *Political Science & Politics, 43,* 303–308. http://dx.doi.org/10.1017/S104909651000017X

Morawski, J. G., & Agronick, G. (1991). A restive legacy: The history of feminist work in experimental and cognitive psychology. *Psychology of Women Quarterly, 15,* 567–579. http://dx.doi.org/10.1111/j.1471-6402.1991.tb00431.x

Moss-Racusin, C. A., Dovidio, J. F., Brescoll, V. L., Graham, M. J., & Handelsman, J. (2012). Science faculty's subtle gender biases favor male students. *Proceedings of the National Academy of Sciences of the United States of America, 109,* 16474–16479. http://dx.doi.org/10.1073/pnas.1211286109

Mullen, L. (2015). *gender: Predict Gender from Names Using Historical Data* (R package version 0.5.1). Retrieved from https://github.com/ropensci/gender

Nittrouer, C. L., Hebl, M. R., Ashburn-Nardo, L., Trump-Steele, R. C. E., Lane, D. M., & Valian, V. (2018). Gender disparities in colloquium speakers at top universities. *Proceedings of the National Academy of Sciences of the United States of America, 115,* 104–108. http://dx.doi.org/10.1073/pnas.1708414115

Nykyforiak, T. (2017, July 6). Research chairs should be based on merit not gender. *Montreal Gazette*. Retrieved from http://www.montrealgazette.com

Parker, L. R., Monteith, M. J., Moss-Racusin, C. A., & Van Camp, A. R. (2018). Promoting concern about gender bias with evidence-based confrontation. *Journal of Experimental Social Psychology, 74,* 8–23. http://dx.doi.org/10.1016/j.jesp.2017.07.009

Peelle, J. E. (2016, February 18). *Measuring conference speaker gender (im)balance*. Retrieved from jonathanpeelle.net/blog/2016/2/18/measuring-conference-speaker-gender-imbalance.

Pennycook, G., & Thompson, V. (2018). An analysis of the Canadian cognitive psychology job market (2006–2016). *Canadian Journal of Experimental Psychology, 72,* 71–80. http://dx.doi.org/10.1037/cep0000149

Rabson, M. (2017, April 27). Science minister mulls forcing universities to attract more female researchers. *The Globe and Mail*. Retrieved from https://beta.theglobeandmail.com

Reuben, E., Sapienza, P., & Zingales, L. (2014). How stereotypes impair women's careers in science. *Proceedings of the National Academy of Sciences of the United States of America, 111,* 4403–4408. http://dx.doi.org/10.1073/pnas.1314788111

Rosser, S. V. (2014). Senior compared to junior women academic scientists: Similar or different needs? *Gender Transformations in the Academy: Advances in Gender Research, 19,* 221–241. http://dx.doi.org/10.1108/S1529-212620140000019010

Sanders, K., Willemsen, T., & Millar, C. (2009). Views from above the glass ceiling: Does the academic environment influence women professors' careers and experiences? *Sex Roles, 60,* 301–312. http://dx.doi.org/10.1007/s11199-008-9547-7

Savonic, D., & Davidson, C. (2017). *Gender Bias in Academe: An Annotated Bibliography of Important Recent Studies*. Retrieved from https://www.hastac.org/blogs/superadmin/2015/01/26/gender-bias-academe-annotated-bibliography-important-recent-studies

Shields, S. (1975). Functionalism, Darwinism, and the psychology of women. *American Psychologist, 30,* 739–754. http://dx.doi.org/10.1037/h0076948

Vaid, J., & Geraci, L. (2016). An examination of women's professional visibility in cognitive psychology. *Feminism & Psychology, 26,* 292–319. http://dx.doi.org/10.1177/0959353516641139

Valian, V. (1998). *Why So Slow? The Advancement of Women*. Cambridge, MA: MIT Press.

Witteman, H. O., Hendricks, M., Straus, S., & Tannenbaum, C. (2017). Female grant applicants are equally successful when peer reviewers assess the science, but not when they assess the scientist. *bioRxiv*. Advance online publication. http://dx.doi.org/10.1101/232868

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