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Researchers in Argentina: Scientific vocation, publication strategies and time-management tactics

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Abstract We wanted to understand how the competitive scientific system affected researchers in Argentina, whose budget to finance science is noticeably lower than in other countries and historically unstable. The objective was to identify factors that influence scientific vocation, main publication strategies and time-management tactics. A structured survey was designed and circulated online for 6 months (2018/2019). The 684 valid responses were separated per academic stage: PhD students (41%), postdoc fellows (21%) and senior researchers (38%). National science policies (answer frequency = 0.69) and resources/funding availability (0.62) had a negative influence on scientific vocation. The difficulties to access to scholarships/full-time positions (0.48) had a negative influence mainly for younger researchers. Peer interaction activities were selected as positive factors for scientific vocation, for example work-team (0.51), which also stimulated the generation of new ideas together with the collaboration with other groups (0.76) and conference attendance (0.59). The most frequent publishing strategy to become a full-time researcher was publishing in high impact journals (0.87). However, young researchers mainly chose to make their findings public at conferences (0.57). Time devoted to scientific production was relevant (0.73) and followed by teaching (0.39), although the last was also the least stimulating activity for the generation of new ideas. Three highlights emerge from our results. First, scientific vocation is negatively affected by structural factors related to the scientific system and positively influenced by peer interaction instances. Second, to publish in high impact journals is the most advisable strategy to become a full-time researcher. Third, the most time-demanding activities are not those that most stimulate the generation of ideas. Emerging recommendations for National Science, Technology, and Innovation Ministry, Universities, and/or research organisms for early-career Argentine researchers are as follows: increase national science budget, encourage work-team meetings and stays abroad, keep contact with local communities, stakeholders and decision-makers.

Key words: academic stage, PhD students, postdoc fellows, scientific motivation, time administration.

INTRODUCTION

The rise in the number of people who do research is not consistent with the economic resources that countries allocate to finance science (Cyranoski *et al.* 2011; Stephan 2012; Yerkes *et al.* 2012). Young researchers often aim at successfully applying for full-time positions to do research, and this is becoming increasingly difficult worldwide (Maher & Sureda Anfres 2016). Postdoc fellow recruitment and hiring procedure at several European Universities showed that more than 85% planned to go on to develop an academic career, while only 3–5% were effectively selected for full-time positions (van der Weijden *et al.* 2016; Herschberg *et al.* 2018). This competitive context also affects PhD students, who face greater competition levels for stable jobs than senior researchers (Nature Editorial 2016). In Argentina, the national budget for science is lower than in other countries (OECD 2020). Research is mainly supported by public funds, and national science policies are historically unstable (Beigel *et al.* 2018). The National Scientific and Technical Research Council (CONICET) awards most of the fellowships and researchers' full-time positions (followed by National Ministry of Science, Technology, and Innovation, state Universities and research organisations). More information is needed on how this context is affecting scientific vocation, that is 'the strong desire to follow the scientific career', of young (PhD students and postdoc fellows) and senior researchers to continue their academic career.

Publication of results in journals, after a strict peer-review process, is the main way of spreading

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and exchanging scientific knowledge. The most influential journals (i.e. with high impact factor, among other indices) comprise those with a large audience and contribute to the progress of knowledge (Fersht 2009). Publishing in those journals has become increasingly difficult, as competition rises, and both reviewers and editors increase their level of demand for each paper (Alberts *et al.* 2014). The high publication pressure usually results in a competitive work environment that encourages short-term goals (Sarewitz 2016). Academic performance of researchers, even when young, is measured by the number and quality of publications (Yerkes *et al.* 2012). In Argentina, the competition to get a full-time position as a CONICET researcher in Biological, Agricultural and Environmental Sciences also generally requires candidates to have publications in international journals (Galetto 2011; Beigel *et al.* 2018). Thus, publishing strategies are numerous and require practice (Gewin 2018). Ideally, the experience to publish should be acquired during the early stages of a PhD experience and be reinforced during a postdoc fellowship. However, researchers are usually required to accomplish diverse activities in addition to publishing (Smaglik 2016), and efficient time-management strategies become crucial for a career in academia.

Outstanding scientific discoveries arise from original ideas after investing time in reading, interacting with peers and, above all, thinking (Alberts *et al.* 2014). This time for reflection is becoming scarce as that devoted to writing and revising funding applications is increasing. Empirical evidence was reported previously about the significant negative impact of this latter activity on researchers´ productivity (Herbert *et al.* 2014). Also, administrative tasks are taking up an ever-increasing fraction of the day and present serious obstacles to concentrating on the scientific mission itself (Powell 2010). Researchers within Universities also invest time in teaching, and human resource training is also added to this multitasking list expected from researchers, both young and senior. It is one of the main challenges for a researcher to manage time efficiently to achieve an active scientific production, to publish in scientific journals and to oversee other tasks, such as teaching and human resource training (Farji-Brener & Ruggiero 2010). Considering the high competitiveness for resources and jobs in science, it is essential to identify which the most awarded activities are, those that are time-consuming and also activities that stimulate ideas and a scientific vocation.

A complex scenario arises for researchers working with a national science budget that is low and unstable, added to the high pressure to publish, and increasingly rigorous requirements in science journals. In analysing this scenario, a range of questions related to the research process emerged: Which factors negatively or positively influence scientific vocation among Argentine researchers? Which are the advisable strategies to become a full-time CONICET researcher? Where do researchers make their findings public? Which activities are the most time-demanding? Which activities stimulate new research ideas? A preliminary interview to Argentine senior researchers consistently highlighted the relevance of achieving high impact publications (Reyes *et al.* 2018). However, there were many features of the research process that needed further exploration. Here, we performed a structured survey with the objective of identifying the factors that influence researchers' scientific vocation, main publication strategies and time-management tactics. Unravelling these key aspects of the research system will be helpful to propose recommendations for early career Argentine researchers and practical measures to support them addressed to Universities and research organisms.

MATERIALS AND METHODS

Survey description

A structured survey was designed through the Google Forms Software as a closed, anonymous online survey, and directed to Biological, Agricultural and Environmental Science Argentine researchers. It included a letter explaining its objective and to whom it was directed. There were four categories of structured questions: (1) Personal profile, (2) Scientific vocation factors, (3) Scientific publication strategies and (4) Time-management tactics. Each category included between 5 and 8 questions, and the majority had a multiple-choice format with a selection limit of 3 or 4 options. Questions concerning number of publication and quality were referred to the SCImago journal quartile ranking classification (Q1-Q4, SCImago 2020), and a category for not indexed, local and technical publications was added. Complete survey questions and answer options are available in the Supplementary material (Appendix S1). Mean answer time was targeted at 15 min. A pilot was released on a subset of 15 PhD students or postdoc fellows, and their feedback was used to enhance survey structure, prior to final spreading.

The survey was available from October 2018 until March 2019, and it was circulated via e-mail and social networks. It was published in newsletters from CONICET, Argentine Ecology Association, Argentine Soil Science Association, and it was promoted during the XXVIII Argentine Ecology Meeting in 2018. Also, to ensure a representative distribution of researchers from different parts of the country, it was distributed to 34 post-graduate schools of Agronomic and Biological sciences nationwide (CONEAU 2019). We received 730 survey answers with academic stage, geographic location and gender distribution similar to the country population (INDEC 2010) and to CONICET statistics (CONICET 2020) (Table 1).

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Table 1. Population distribution in Argentina, CONICET researchers and survey results, considering academic stage, geographical distribution and gender

	Country (INDEC, 2010)[†]	CONICET (2018-2019)[‡]	Survey
Academic stage			
PhD students		53%	41%
Postdoc fellows		17%	21%
Senior researchers		30%	38%
Geographical distribution			
Buenos Aires (capital and province)	46%	50%	52%
Centre-East	19%	25%	14%
Centre-West	7%	8%	10%
North East	9%	2%	4%
North West	10%	6%	8%
South	5%	9%	11%
Gender[§]			
Women	51%	53%	63%
Men	49%	47%	37%

[†]Distribution of population within country.
[‡]Researchers from Agronomy, Exact and Natural sciences.
[§]Gender from country population considered people between 15 and 64 years old. The survey also included a third category as 'other' gender, with 1 answer.

Data analysis

A strict validation procedure was applied (Lavrakas 2008). From the 730 people that completed the survey, we selected 684 to work with as those remaining had important missing information or answers were inconsistent. To evaluate the results from the multiple-choice questions (three or four options selected by each respondent), we counted the number of times each of the response options was selected. This number was then divided by the number of respondents per academic stage, to make the variable independent of the number of respondents. This variable was called 'answer frequency', and it does not add up to one.

In order to study the possible presence of a major bias in the survey, related to respondent selection issues (Weisberg, 2005), we verified if the answers were correlated to any structural variable. To do this, we calculated the 'coefficient of variation' (CV) sorted by structural groups representing: gender, maternity/paternity, institutional affiliation, geographic location and current total number of publications. For each group, we calculated the CV as the ratio of the standard deviation to the mean 'answer frequency'. It is a parameter that quantifies the variability of the response variable, regardless of its magnitude (Barde & Barde, 2012). The largest CV values correspond to larger dispersions, and small CV values indicate that the compared variables have a similar dispersion. In the case of the most frequent answers (answer frequency > 0.3) in the questions strictly related to our objective (i.e. negative/positive influencing factors, time-management strategies and publication tactics), the average CV was 12%. Therefore, in our analysis, we did not detect any major bias in the data set based on any of the structural variables. Neither was there an important difference in the answer frequency according to gender, despite the fact that the representation of women in the survey was slightly higher than the number of women in the country and in CONICET statistics.

Afterwards, we classified information per academic stage: PhD students, postdoc fellows and senior researchers, according to the profile section information. Senior researchers were considered those with a permanent position at CONICET. Researchers, other than CONICET researchers (from Universities and INTA: National Institute of Agricultural Technology), were asked to self-classify themselves in the survey answers, and we checked for answer coherence. When the answer frequency per academic stage was larger than 0.3 and showed a relevant variation (CV > 25%) among structural variables, this was made explicit.

RESULTS

Negative and positive factors that influence scientific vocation

There was a clearly specific pattern in the negative and positive factors affecting researchers´ scientific vocation (Fig. 1). In every academic stage, national science policies and resource/funding availability were the negative factors with the largest frequencies (average frequencies for all researchers were 0.69 and 0.62, respectively). Access feasibility to scholarships/full-time CONICET positions was mostly selected as a factor that negatively affected scientific vocation of PhD students and postdoc fellows (average answer frequency for both stages = 0.44). Postdoctoral female researchers selected this latter negative factor with higher answer frequency (0.58) than males (0.29). Workplace environment was selected as a negative factor with a higher answer frequency (0.31) by postdoc fellows with more than 10 current publications.

The most selected positive factors were work-team (average for all researchers = 0.51), workplace environment (0.47), personal/family circumstances (0.40) and supervisor´s guidance (0.35, Fig. 1). Most senior researchers selected the workplace environment as a positive factor (0.48, Fig. 1c), although an important number also selected it as a negative factor (0.24). A similar pattern was observed in younger researchers (0.40 positive *vs.* 0.15 negative, on average for PhDs, and postdocs, Fig. 1a-b). Postdoc fellows with more than 10 publications selected workplace environment as positive, with higher answer frequency (0.63) compared to those with 10 or less publications (average = 0.39, Appendix S2).

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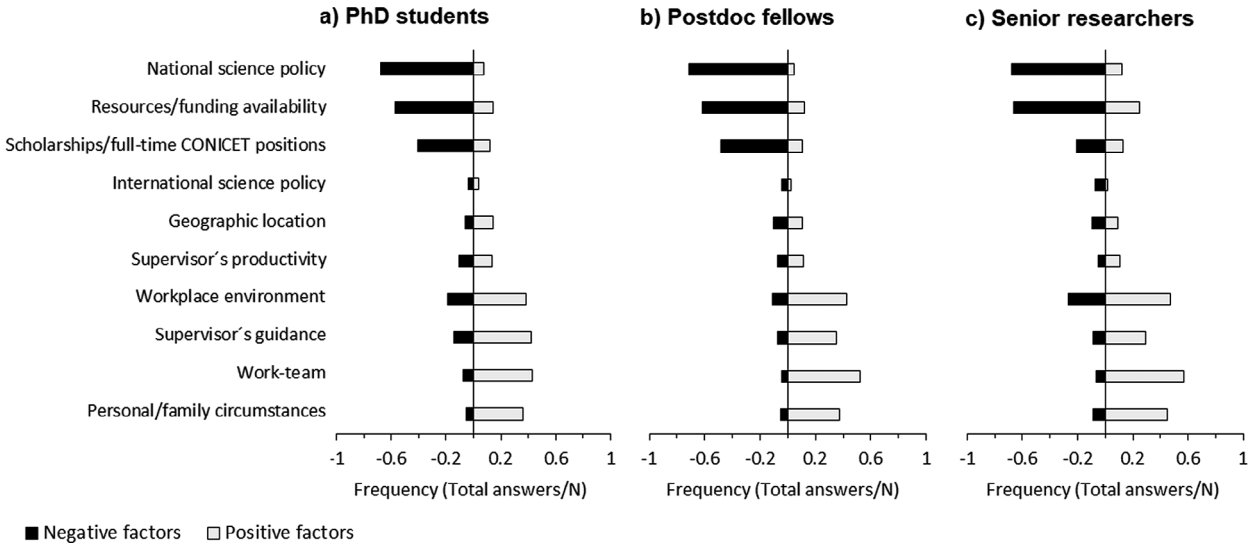

Fig 1. Negative and positive factors that influence scientific vocation according to academic stage: (a) PhD students, (b) postdoc fellows, (c) senior researchers. Survey question addressed here was 3.3 (negative factor) and 3.2 (positive factor), Which of the following contexts do you consider to negatively/positively influence your vocation as a researcher? Response variable was calculated as the number of times that an option was chosen relative to the number of respondents per academic stage (N), resulting in an answer frequency value between 0.0 and 1.0. For figure design, answer frequency form negative factors were incorporated as negative values.

Main publication strategies

Researchers from the three academic stages were consistent in their answers concerning the advisable publication strategies to become a full-time CONICET researcher (Fig. 2a). The dominant strategy was to publish in Q1 journals (average = 0.87), followed by publications as co-authors (0.43) and publications in Q2-Q3 journals (0.31). The other options, book chapters, conferences, other, not indexed and Q4 journals, were less frequently mentioned (<0.13). However, the publishing strategies presently implemented, especially those reported by young researchers, differed from this recommended hierarchy (Fig. 2b). Making findings public at conferences was a very frequent strategy for both PhD students and postdoctoral fellows (average = 0.57). This strategy was mentioned more frequently by women (0.56) compared to men (0.34), and this trend increased with the academic stage from PhD students (CV = 16%) to postdoc fellows (CV = 25%), and senior researchers (CV = 63%, Appendix S2). The usual strategy of publishing in first quartile (Q1) journals was mentioned most frequently by senior researchers (0.83), followed by postdoctoral fellows (0.73) and PhD students (0.50). To publish as co-authors (average = 0.39) was also an option regularly chosen along with publishing in Q2-Q3 journals (average = 0.40).

Most postdoc fellows (69%) were interested in obtaining a full-time position as CONICET researchers (*data not shown*). This answer was correlated to the number of publications: the majority of those who reported between 4 and 10 current publications said they would apply (80%), just as those who reported between 11 and 20 publications (69%), whereas a 47% of the postdocs declaring less than 3 current publications were uncertain or decided not to apply to a full-time position at CONICET (Appendix S2). Many PhD students were doubtful about their future in academia (44%) or had already decided not to apply for CONICET (9%) (Appendix S2).

The number of publications when researchers started working as full-time CONICET researchers did not vary much from 2005 to 2017 (Fig. 3). Researchers declared having a total of 8.4 ± 0.3 papers (average $\pm$ standard error), and from these, total 3.1 ± 0.2 publications were as first authors in Q1 journals. Annual average publication rate of senior researchers after becoming full-time CONICET researchers was 2.0 ± 0.1 publications per year (calculated from information provided by respondents). Between 1990 and 2004, the number of publications when joining CONICET was slightly higher and more variable, with 10 to 11 total papers and 3 to 5 papers in Q1 journals.

Time-management approaches and idea stimulators

The majority of respondents spent most of their time during 2018–2019 in scientific production (0.73) and teaching (0.39) (Fig. 4). PhD students devoted time

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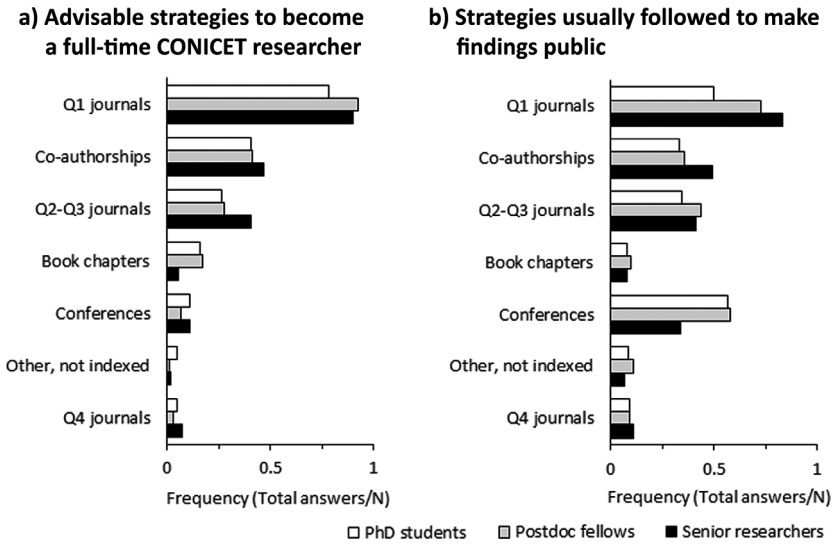

Fig 2. (a) Advisable strategies to become a full-time CONICET researcher. Survey question addressed here was 2.4, What do you consider to be the best strategies to become a full-time CONICET researcher in relation to publications? (b) Strategies normally followed to publish research findings. Survey question addressed here was 2.3, Which of the following options do you usually use to make findings public? Response variable was calculated as the number of times an option was chosen relative to the number of respondents per academic stage (N), resulting in an answer frequency value between 0.0 and 1.0.

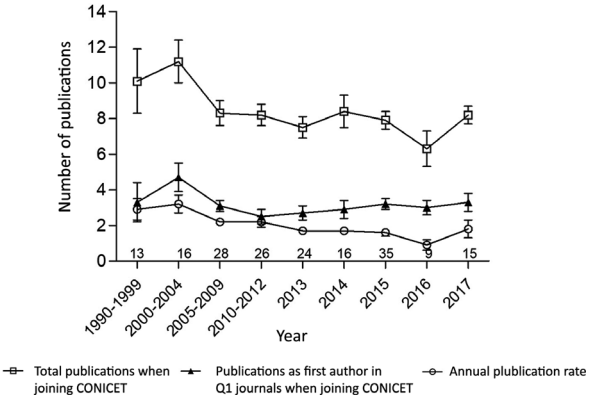

Fig 3. Publication number when joining CONICET as a full-time national researcher (*x*-axis), and annual publication rate, calculated from the ratio between the number of publications when answering the survey and the number of publications when joining CONICET as a researcher. Survey questions addressed here were 1.3, 1.6, 1.7, and 1.8. Values are average ± standard error; number of respondents is indicated above the x-axis line for each year (or range of years).

to courses (0.41) and thesis writing (0.36), postdoc fellows invested time in scholarship applications (0.32), and senior researchers in human resource training (0.38) and funding application (0.32). The relevance of teaching was higher in those postdoc fellows and senior researchers working in Universities (average = 0.58), compared to those with other affiliations (average = 0.22). In addition, PhD students and postdoc fellows included between three and four extra secondary activities to these three main activities, while senior researchers between four and five (data not shown).

Although teaching was one of the most time-demanding activities, it was also the least selected option as a stimulator for the development of research lines (Fig. 5). The best activities to stimulate ideas were peer interaction instances such as collaborations with other groups (0.76), conference attendance (0.59), and stays abroad (0.48). Postdoc fellows with children marked the option stays abroad with less answer frequency (0.38) than those without children (0.55, Appendix S2). Daily scientific reading was also pointed out as a stimulating activity (0.40). PhD students also highlighted courses (0.35) as idea stimulators, while postdoc fellows marked human resource training (0.29). Contact and interaction with the local communities, stakeholders, and decision-makers (0.26) and participation in cooperation networks (0.26) were chosen with a similar answer frequency among academic stages.

DISCUSSION

Three highlights emerge from our results. Firstly, scientific vocation in Argentina is negatively affected by structural factors related to the scientific system and positively influenced by peer interaction instances. National science policies were the main structural factors selected as negative. In fact, national science budget in Argentina is low, although the resource use

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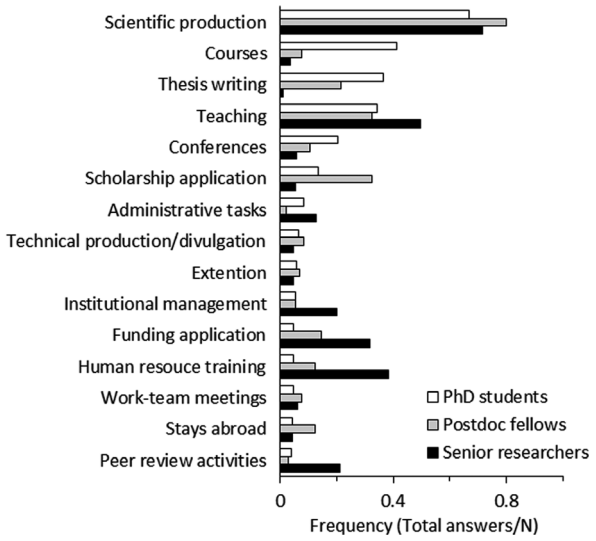

Fig 4. Time-management tactics. The main activities comprising more than 75% of time during 2018 according to academic stage. Survey question addressed here was 4.1, Which of the following activities involved a significant proportion (>25% each) of your working time during the last year? Response variable was calculated as the number of times an option was chosen relative to the number of respondents per academic stage (N), resulting in a frequency value between 0.0 and 1.0.

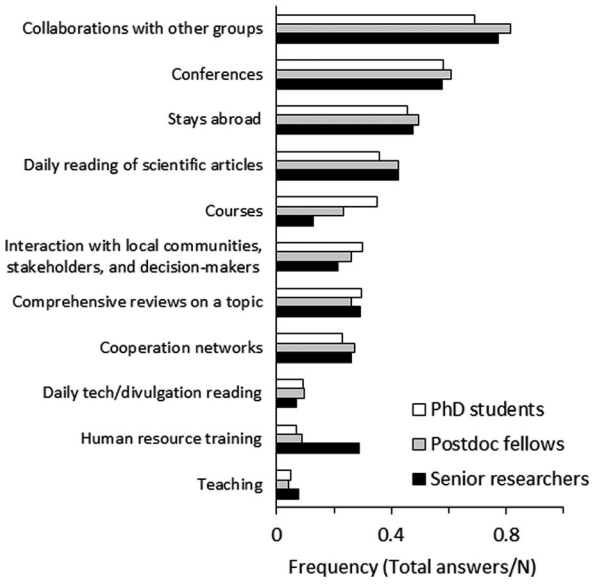

Fig 5. Activities that stimulate idea generation and help develop a research line according to academic stage. Survey question addressed here was 4.3, Which of the following activities stimulate the generation of ideas and the development of a line of research? Response variable was calculated as the number of times an option was chosen relative to the number of respondents per academic stage (N), resulting in an answer frequency value between 0.0 and 1.0.

efficiency is high when adjusting the number of total publications by the amount of invested money (Holmgren & Schnitzer 2004). Seventy per cent of the respondent postdoc fellows were interested in a career in academia, but the (low) availability of scholarship/full-time CONICET positions was selected as a negative influence. If your work position is stable, then it is easier to accept the uncertainties of the scientific system (Thomson 2010). This is relevant to understand why senior researchers were not as worried as young researchers by the low availability of full-time positions. The longer the postdoc employment based on successive scholarships, the higher the career dissatisfaction becomes (van der Weijden *et al.* 2016). Peer interaction not only had a positive influence but was also selected as new idea stimulator. Doing science now is not a solitary activity, which is evidenced by an increase in the number of authors per article (Baethge 2008), and collaborating is recommended for early-career researchers (Pastor *et al.* 2020). Work-team had a positive influence and was career stage independent, which was identified as a key to having a positive doctoral or postdoctoral experience (Scaffidi & Berman 2011; Virtanen *et al.* 2017). Workplace environment was also frequently pointed out by young researchers, mostly as positive but also as a negative influence.

The second item highlighted that the advisable strategies to become a full-time researcher were less diverse than what is usually performed to make findings public. Those who are starting in the scientific activity must be aware that the priority should be to publish, rather than get involved in various activities. Publication in scientific peer-reviewed journals is the way to reach a broader audience and have a higher impact. Those international standards make national journals less competitive (Beigel, 2014; Costa 2019). Nevertheless, the motivation of interacting with peers at conferences can partly explain why researchers attend those events so frequently. Also, conference attendance might be a way to publish findings in the short term, as it is never too early to start writing a manuscript based on research presented at a meeting or as a poster (Powell 2010). As it was not possible to check whether these results presented at conferences were published in international journals, this gap was identified as a limitation of our survey. However, our results show that eight out of ten PhD students knew they had to publish in Q1 journals, but only five out of ten actually did. Therefore, there is a great deal of young researchers that present their works at conferences but do not get to publish in high impact journals as much as they would like to. This may mean that getting a paper published can take considerable time for a researcher in early career stages.

The third highlighted item showed that some of the most time-demanding activities are not those that

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most stimulate the generation of ideas. This was especially evident with teaching, a main time-demanding activity for researchers working at Universities, which was the least mentioned as idea stimulator. In fact, equilibrium between time spent teaching and doing research is required (Hattie & Marsh 1996), particularly for those who teach as a supplementary activity. Nonetheless, a full-time position at the university is a very good job opportunity for researchers. A similar argument could be made regarding funding request and fellowship applications: both are time-consuming but were not highly selected as idea-stimulator activities. It appears that researchers that engage perform better (Jensen *et al.* 2008), although the shape of social engagement is still on debate (Besley *et al.* 2018). Quite similar popularisation actions by researchers, those directed to a non-science audience, were taken by researchers in quite different countries like Argentina, UK and France. In consequence, popularisation activities, like contact with actors, were stimulating (Kreimer *et al.* 2011). Postdoc fellows with children apparently found stays abroad as less stimulating than those without children, stating that family organisation for achieving these activities is a challenge (Shen 2013).

CONCLUDING REMARKS

Based on our results, we propose several recommendations for National Science, Technology, Innovation Ministry, Universities and research organisms for early-career Argentine researchers:

- Increasing national science budget will make Argentine researchers more competitive in international publications. This will allow buying new equipment, the assistance of skilled technicians, cover field trips, publication fees, among others.
- Encourage work-team meetings to promote discussion during different steps of the research process. Peer interaction will boost scientific publications, which should be a priority during early stages.
- Seek opportunities to carry out stays abroad with other research groups to interact with regional (Likens & Lindenmeyer 2011; Anderson *et al.* 2012; Pastor *et al.* 2020) or global research networks (Müller 2012). Promote framework agreements among institutions and facilitate access to scholarships for short-term research stays in Argentina or abroad is a way to support this (Ortlieb & Weiss 2018).
- Keep contact with local communities, stakeholders, and decision-makers, both directly and through divulgation activities, which can stimulate the generation of new ideas and is a way to integrate research into policy (Watson 2005; Toomey *et al.* 2017; Schur *et al.* 2019). Research organisms should encourage this kind of activities in an effective way and researchers' evaluation should take this into account as well (Parker *et al.* 2010).

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CONFLICT OF INTEREST

The authors declare that there is no conflict of interests.

AUTHOR CONTRIBUTION

Josefina Luisa De Paepe: Formal analysis (lead); Investigation (lead); Methodology (lead); Writing-original draft (lead); Writing-review & editing (lead). **M. Fernanda Reyes:** Conceptualization (equal); Formal analysis (equal); Methodology (equal); Writing-original draft (supporting); Writing-review & editing (supporting). **María Victoria Piazza:** Formal analysis (equal); Methodology (equal); Writing-review & editing (equal). **Carla Di Bella:** Conceptualization (supporting); Formal analysis (supporting); Investigation (supporting). **Pablo Adrián García Parisi:** Conceptualization (supporting); Formal analysis (supporting); Investigation (supporting). **Patricio Hernán Straccia:** Formal analysis (supporting); Methodology (supporting); Writing-original draft (supporting); Writing-review & editing (supporting).

Data availability statement

The data sets generated during and/or analysed during the current study are available from the corresponding author on reasonable request.

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SUPPORTING INFORMATION

Additional supporting information may/can be found online in the supporting information tab for this article.

Appendix S1. Survey questions and answer options.

Appendix S2. Survey answer coefficients of variation.

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