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A possible role of social activity to explain differences in publication output among ecologists

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Publication output is the standard by which scientific productivity is evaluated. Despite a plethora of papers on the issue of publication and citation biases, no study has so far considered a possible effect of social activities on publication output. One of the most frequent social activities in the world is drinking alcohol. In Europe, most alcohol is consumed as beer and, based on well known negative effects of alcohol consumption on cognitive performance, I predicted negative correlations between beer consumption and several measures of scientific performance. Using a survey from the Czech Republic, that has the highest per capita beer consumption rate in the world, I show that increasing per capita beer consumption is associated with lower numbers of papers, total citations, and citations per paper (a surrogate measure of paper quality). In addition I found the same predicted trends in comparison of two separate geographic areas within the Czech Republic that are also known to differ in beer consumption rates. These correlations are consistent with the possibility that leisure time social activities might influence the quality and quantity of scientific work and may be potential sources of publication and citation biases.

Publication success (i.e. the number and citation rate of scientific papers) is a widely used surrogate metric in assessments of the academic performance at all levels from individual scientists to national reviews (Cassey and Blackburn 2004, Leimu and Koricheva 2005). Both publication and citation success were previously shown to be influenced by variety of factors, including statistical (non)significance of results, number of co-authors, last name of co-authors, nationality and scientific field of enquiry (Møller and Jennions 2002, Tregenza 2002, Leimu and Koricheva 2005, Wong and Kokko 2005). However, to my knowledge no study has to date investigated external factors less tightly connected to the publication process itself, e.g. social and recreational activities (cf. Fig. 2 in Lortie et al. 2007).

One of the most common social activities in the world is alcohol consumption – estimated ''2 billion people worldwide consume alcoholic beverages'' (World Health Organization 2004, p. 1). In Europe, this is mostly in the form of beer drinking (World Health Organization 2004, Table 4). I chose to test the effect of alcohol consumption on scientific performance because this hypothesis leads to unequivocal predictions. This is because it is well known that alcoholic drinks negatively affect human cognitive capabilities that are critical for any physical and mental performance not to speak of such a demanding activity as producing a high quality science. Specifically, alcoholic beverages, including beer, impair ''memory, abstracting, problem-solving, perceptual analysis and synthesis, speed of information processing, and efficiency'' (Parsons 1998, p. 954). Thus, human cognitive performance during and after drinking is decreased at least in the short term and costs of beer drinking extend beyond the mere time spent with this activity. This does not specifically hold for other recreational activities. Moreover, potential effects on scientific productivity of other such activities, e.g. mountain climbing or picking mushrooms (Røskaft et al. 2004), are unclear and hard to predict. Further, alcohol consumption is positively associated with depressive symptoms (Palfai et al. 2007) and depression, with symptomatic loss of motivation, adversely affects work productivity (Stewart et al. 2003). Moreover, cooperativeness is critical for successful performance in science (Leimu and Koricheva 2005) and alcohol was shown to significantly decrease cooperativeness within groups (Hopthrow et al. 2007). Alcohol drinking also leads to work alienation (Greenberg and Grunberg 1995). Thus, both short-term direct (physiological) and long-term indirect (psychological) effects of alcohol use are well known to decrease mental and working performance in general. Here I predict the same negative effects for scientific performance in particular. The Czech Republic, with traditionally the highest consumption of beer per capita in the world (156.9 litres per year; Kirin Research Institute of Drinking and

Lifestyle 2005), seems to be a good candidate to test this hypothesis.

A survey of beer consumption among research scientists

I surveyed all researchers studying avian evolutionary biology and behavioural ecology (my own discipline) in the Czech Republic who published at least one paper in a peer-reviewed journal listed by the Web of Science (http://portal17.isiknowledge.com/portal.cgi) and published outside the Czech Republic during the last two decades. I asked how many glasses or bottles of beer they drank per week and recalculated this value to estimate annual consumption in litres. In addition, I collated data on their year of birth to control for age effects. I collated the data in May 2002 and repeated the study four years later in March 2006 with the same subjects where available. Beer consumption appeared to be highly consistent with advancing years (linear regression of 2006 against 2002 consumption: $R^2 = 0.90$, $F_{1,9} = 61.5$, $p < 0.0001$). All variables were transformed by Box-Cox transformation to fit normal distributions and all analyses were conducted in JMP software (SAS Inst. Inc. 1995).

I conducted two separate analyses. First, I analyzed data from the first census in 2002 ($n = 18$). Second, I collated data on new researchers who started to publish after the first census in 2002 and analyzed the total data set ($n = 34$). I controlled for the duration of publication activity (i.e. the period from publishing the first paper until the date of my research) and the researchers' age. The duration and age were intercorrelated ($r_s = 0.86$, $p < 0.0001$), therefore I performed principal component analysis (PCA) on these two confounding variables. PC1 explained 89.6% of variance in the data and was positively correlated with both age and duration (both $r_s = 0.93$, $p < 0.0001$).

For both data sets I fitted regression models with beer consumption and PC1 as effect variables and (1) number of papers, (2) number of citations and (3) the average number of citations per paper (a surrogate measure of paper quality) as response variables respectively. I selected final models based on backward elimination of nonsignificant variables (under conventional $\alpha = 0.05$). In both full and final reduced models I checked plots of residuals for deviations from normality of error, linearity of effects and homogeneity of variance (Grafen and Hails 2002).

Results of beer drinking on publication success

The amount of beer consumed per year was significantly and negatively related to the total number of papers published, the total number of citations received and the average number of citations received per paper (Table 1, Fig. 1). The results were consistent across both 2002 and 2006 data sets when I controlled for time effects (PC1) and also when non-significant confounding effects were dropped from final reduced models (Table 1).

It would be interesting to test whether changes in beer consumption between 2002 and 2006 predicted changes in publication output. Unfortunately, changes in per capita consumption were very small (see above) thus effectively eliminating the potential value of beer consumption changes to explain temporal publication patters.

Generally, inhabitants of Bohemia (western region of the Czech Republic) are known to drink more beer than people from Moravia (eastern region of the country). This difference was confirmed for my sample of researchers: researchers from Bohemia drank significantly more beer per capita per year (median 200.0 litres) than those from Moravia (median 37.5 litres; Mann-Whitney test: $U_{17,17} = -2.84$, $p = 0.005$). Therefore I predicted lower measures of publication output for the former in comparison to latter group of researchers (I could not include nominal variable "region" in regression models because of its significant interdependence with another effect variable, the beer consumption). Indeed, researchers from Bohemia published fewer papers per year ($U_{17,17} = 2.32$, $p = 0.02$), were less cited per year ($U_{17,17} = 2.99$, $p = 0.003$), and showed lower citation rate per paper per year ($U_{17,17} = 2.30$, $p = 0.02$). When controlling for researchers' age (instead of the duration of publication activity), the results were qualitatively similar for the number of papers ($U_{17,17} = 3.29$, $p = 0.001$), citations ($U_{17,17} = 2.95$, $p = 0.003$) and citations per paper ($U_{17,17} = 2.61$, $p = 0.009$). Moreover, the results remained qualitatively similar for the original subset of researchers both in 2002 and 2006 (2002 data: Bohemia $n = 6$, Moravia $n = 12$; results not shown; all 12 tests

Table 1. Results of minimal adequate regression models with beer consumption (litres per year) as a fixed effect and respective publication parameter as a response variable. All original full models controlled for the duration of publication activity (i.e. the period from publishing the first paper until the date of my research) and the researchers' age using PC1 calculated from these two intercorrelated confounding variables (see the main text for details). In 2002 analyses of PC1 had nonsignificant effects in all instances (all $p > 0.17$) and were removed from final reduced models (when the PC1 was not removed the beer consumption still had significant effects and model parameters were almost quantitatively identical to those presented below). In 2006 analyses PC1 had significant effects in all instances (all $p < 0.001$) and was retained in final models. Parameter estimates (t-statistic, p-values) are shown only for the effect of beer consumption for clarity.

2002 data set	R^2	$F_{3,14}$	p	t	p
No. of publications	0.34	8.3	0.010	−2.9	0.01
No. of citations	0.36	9.0	0.008	−2.0	0.008
No. of citations per paper	0.26	5.5	0.030	−2.4	0.03
2006 data set	R^2	$F_{3,33}$	p	t	p
No. of publications	0.52	17.1	<0.0001	−2.8	0.01
No. of citations	0.53	17.8	<0.0001	−2.4	0.02
No. of citations per paper	0.42	11.1	0.0002	−1.8	0.08

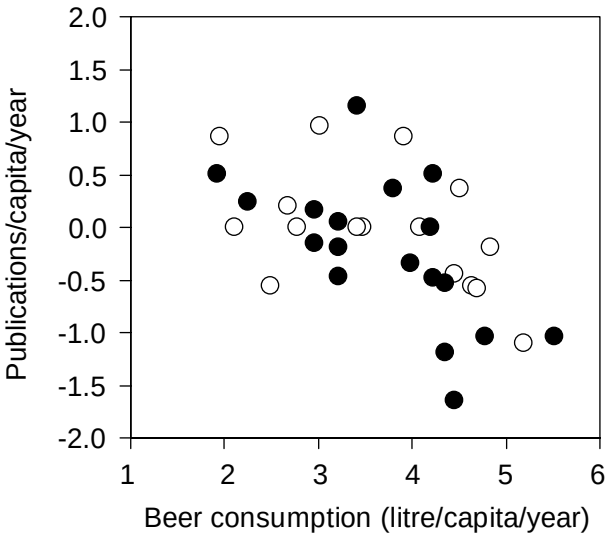

Fig. 1. Number of publications per capita per year published by Czech avian ecologists up to 2006 plotted against their beer consumption per capita per year in litres. Both data sets shown are Box-Cox transformed (thus neither the output score nor the consumption score values enable the identification of particular persons included in this research). The negative relationship between beer consumption and publication success is significant not only for the whole data set ($r_s = -0.55$, $n = 34$, $p = 0.0008$) but also for "past" (included in the first survey in 2002; ●) and "present" researchers (included in 2006; ○) analyzed separately ("past": $r_s = -0.68$, $n = 18$, $p = 0.002$; "present": $r_s = -0.52$, $n = 16$, $p = 0.04$).

with p values: $0.007 < p < 0.09$). Bohemian and Moravian researchers did not differ in the average age when they started to publish (median: 28 vs 27 years; $U_{17,17} = -0.95$, $p = 0.33$). Also, there is no evidence for discrimination in funding support against researchers from Bohemia (personal inquiry at the Grant Agency of the Czech Republic). Thus, beer drinking may negatively influence publication output not only at individual but also at regional level.

Discussion and implications

Although the current study is based on a limited sample (i.e. researchers from a single country focusing on a single scientific discipline) and is correlational in nature, it is important to stress that the majority of exploratory evolutionary biology and behavioural ecology studies are also based on data from a single population of a single study species. In fact, my single country approach is advantageous in comparison to some studies that pooled data from various states (Wong and Kokko 2005) as it cannot in principle be confounded by differences among countries (cultural, nutritional, or funding-related). In addition, I was able to get valid responses for my analyses from most Czech avian ecologists publishing in foreign journals during the study period (34 out of 38 researchers). This 89% respondent success is noticeably higher than in other studies of publication success (e.g. 40% in Cassey and Blackburn 2004). At the same time it must be acknowledged that the form and social context of alcohol consumption (and its price) varies widely between countries, continents, and cultures (World Health Organization 2004), and so it remains to be determined how general the patterns reported here from the Czech Republic might be on a global scale.

The hypothesis of "social effects on publication success" and supporting correlative results between beer consumption rates and publication success presented herein have direct bearing not only on assessments of publication biases but also on understanding of human behavioural ecology (Buss 2004). At research universities and institutes publication success is critical for (1) being hired, (2) staying employed and (3) being promoted to a higher position and ultimately a tenure as every researcher well knows first-hand (see also Fleet et al. 2006). To stay employed as a scientist and/or university teacher has important consequences for personal social status: e.g. in my home country these professions are traditionally considered the most prestigious being surpassed only by "physician" (Cervenka 2006). Importantly, publication success directly influences both financial income and social status both of which are known to affect fitness (Hopcroft 2006, Hauber 2007). Thus, quantity and quality of publications may have far reaching consequences for social success of academic workers and, consequently, may affect their biological success as well. This hypothesis and questions about the physiological, social and/or psychological mechanism behind observed correlations provide ample opportunities for future research.

The results of the current study are of general interest not only to behavioural ecologists but also to scientists in other fields. First, the results suggest that considering social activities could be useful for understanding a quality of scientific work and potential sources of publication and citation biases. Second, the well known relationship among publication output, the success in academic career, money income, social status and fitness may also be affected by social activities which, to my knowledge, has not been considered before.

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