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EDITORIAL

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Science in flux: Registered reports and beyond at the *European Journal of Neuroscience*

The culture of science is changing. Faced with the realisation that much research in the life sciences is unreliable (Academy of Medical Sciences, 2015; Munafò et al., 2017), researchers, journals and funders are mobilising to elevate transparency and reproducibility up the agenda. Among a wide range of open science initiatives, open data, open materials/code, and preregistration of study protocols are becoming increasingly regarded as desirable, if not essential, in the pursuit of scientific discovery.

The Registered Reports article type, which formalises one route for study preregistration, is among the foremost reforms taking hold. Originally launched in 2013 at the journal *Cortex*, Registered Reports place a premium on theory and methodology by performing peer review of study protocols before researchers embark on their research (https://cos.io/rr/). Positively reviewed protocols are then accepted by the journal in advance, locking down the preregistered methods and guaranteeing that the outcomes will be published regardless of whether or not the hypotheses are supported. The core aim of this initiative is to reduce bias in hypothesis-driven science, first by logically eliminating publication bias for positive (or indeed any kind of) results, and second by limiting both the incentive and opportunity for researchers to employ biased inferential practices such as selective reporting of certain outcomes or presenting post hoc hypotheses as a priori. Because of the many clear benefits this format brings to authors and the scientific community, Registered Reports are now offered by 156 journals, with over 150 published articles (and rising), and the number of adopting journals roughly doubling each year.

The *European Journal of Neuroscience* was one of the earliest adopters of Registered Reports (Chambers, Forstmann, & Pruszynski, 2017), and today, nearly 2 years after launch we are seeing the first outcomes of this initiative. In our first published Stage 2 submission, Ait Ouares, Beurrier, Canepari, Laverne, and Kuczewski (in press) ask whether light in the range typically used in optogenetic experiments can influence neuronal physiology in naïve (genetically unaltered) cells and, if so by what mechanism this effect occurs and whether it is specific for certain cell types. Across eight experiments in mice, coordinated over three laboratories, they find that light stimulation can indeed causally influence neuronal activity, with the effect depending on light power and cell type, and most likely caused by changes in temperature. Their findings underline the importance of wild-type control conditions in optogenetics experiments and, intriguingly, suggest a potential application of optical brain stimulation in humans.

As well as being *EJN*'s first published Registered Report, Ait Ouares et al.'s tour de force is to our knowledge the first Registered Report to be published in animal neurophysiology. We hope this milestone will trigger many more such submissions within neurophysiology and animal research more generally. To date, at *EJN* we have received ten Stage 1 Registered Reports for consideration, mainly proposing tDCS, MRI and EEG studies in human, with numbers rising and several already awarded in principle acceptance.

As Registered Reports continue their expansion within *EJN* and beyond, it is important to monitor their impact and take stock of the wider environment in which such reforms are occurring. The first meta-scientific study of Registered Reports led by Hardwicke and Ioannidis (2018) reported deficiencies in the standardisation and transparency of accepted Stage 1 protocols across many journals. In response, we reaffirm *EJN*'s commitment to ensuring that all accepted Stage 1 protocols are publicly archived and linked with published Stage 2 articles, and we are also considering innovations to further standardise and optimise the format of Stage 1 protocols (Chambers & Mellor, 2018). Despite these teething problems, a recent analysis by Allen and Mehler (2018) suggests that Registered Reports are working as intended in controlling bias. They found that the a priori hypotheses proposed in over 100 published Registered Reports were at least three times less likely to be supported by the results compared with regular articles. Although retrospective (and thus permitting only correlational rather than causal conclusions), these findings are revealing what we would expect to see if the format succeeds in curbing publication bias and selective reporting. Where our predictions are wrong more often than we realise, Registered Reports – properly implemented – should help set us straight.

Beyond Registered Reports, even more extensive publishing reforms are underway in the life sciences. Registered Reports champion deductive, hypothesis-driven science, but inductive or abductive processes are equally important in scientific discovery. In response, journals such as *Cortex* and *BMJ Open Science* have recently launched an Exploratory Reports format to provide a dedicated home for transparent

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exploration, free from the pressure to shoehorn exploratory science into a confirmatory framework (e.g. McIntosh, 2017). At the opposite end of the spectrum, some journals are experimenting with highly confirmatory "accountable replications" policies, which commit the journal to publishing any methodologically sound replication attempt of any previous article published within the same journal. This ingenious concept – devised by Srivastava (2012) – does more than simply present reproducibility as a desirable ingredient in science; it makes a journal reputationally accountable for the reproducibility of the work that it publishes. The journal *Royal Society Open Science* recently launched its own accountable replications policy (Chambers, 2018), and at *EJN* we will soon do likewise.

As these article-level initiatives are unfolding, some five thousand journals, including *EJN*, have signed the Transparency and Openness Promotion (TOP) guidelines. Transparency and Openness Promotion signatories commit to self-certifying their level of adherence to a series of modular standards for increasing transparent practices, including citation practices, archiving of data, code and digital study materials, preregistration and replication (Nosek et al., 2015; see http://cos.io/top/). At *EJN* we will be deciding very soon our levels of TOP adoption and implementing them accordingly.

Why does all of this matter? It matters because science matters. Journals and their editors bear a heavy responsibility as gatekeepers of the scientific record. At *EJN* we take this role seriously, which is why we are doing everything possible to create positive opportunities for neuroscientists to embrace transparent research practices. We recognise that to some researchers, these possibilities and practices can seem unusual, even threatening. In response, we would suggest that they are liberating, freeing scientists from the grip of pernicious career incentives that drive selective reporting and publication bias, while simultaneously increasing the rigour of published research.

As we publish our first Registered Report submission, we want to especially thank all the authors and expert reviewers who have supported the initiative at *EJN* and helped cement Registered Reports in mainstream science. With your continuing support, the future of open neuroscience is bright.

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