Citizen Science and Psychology: An Evaluation of Chances and Risks

JOACHIM FUNKE

Department of Psychology, Heidelberg University

Abstract

Under the umbrella term of "Citizen Science", a new paradigm for doing science is gaining attention. This article reviews the chances and risks associated with the new movement. Citizen Science is related to the broader "Open Science" movement and thus supports a paradigm shift in doing science. Psychological science will profit from opening itself up to interested non-professionals but at the same time, it has to watch out for and protect its scientific principles.

1 Introduction

Citizen Science (CS) has become a new trend in different scientific disciplines. According to Wikipedia, CS "is scientific research conducted, in whole or in part, by amateur (or nonprofessional) scientists. CS is sometimes described as 'public participation in scientific research,' participatory monitoring and participatory action research". In a recent advice paper issued by the "League of European Research Universities" concerning CS (LERU, 2016), CS is defined as "the active involvement of non-professional scientists in research".

First support for this new movement came from the book publication from Alan Irwin (1995). Irwin was originally interested in sustainable development and examined the interplay of science and society. He was well aware of the many problems connected to such an approach when he wrote:

> . . . one of the most exciting aspects of the developing context for science, citizenship and sustainability concerns the new possibilities created for a constructive, challenging and forward-looking relationship between science, public groups and the social sciences. Issues of citizen science inevitably draw upon all three as has been extensively discussed. For social science, this will pose a challenge as great as that to the other two categories. (p. 180)

Irwin discussed CS as a way to deal with the “Risikogesellschaft” (society at risk), a term coined in 1986 by German sociologist Ulrich Beck (see, e.g., Beck, 2009) to describe the risks technology carries for society. Nearly 30 years later, the influential German Council of Science and Humanities (“Wissenschaftsrat”), which provides advice to the German Federal Government and the State Governments on the structure and development of higher education and research, recently discussed the usefulness of CS and other participatory methods for dealing with big societal challenges like climate change or clean energy (Wissenschaftsrat, 2015). It seems that it takes a lot of time for a concept to disseminate. Within the discipline of psychology, it might take even longer than in other disciplines (due to several reasons, some of which will be discussed below).

Using untrained citizens to assist in scientific activities has a long tradition in certain scientific disciplines. For example, in astronomy, volunteers help scan huge amounts of data in search of dust particles (see Westphal & Trieloff, this volume); in biology, volunteers count the frequencies of birds sighted in a specific region (see Wink, this volume); and in geography, volunteers help identify the starting point of the yearly apple blossom (see Gerhard, Wolf & Siegmund, this volume). In more applied disciplines, the use of amateurs is not as easy to imagine: surgical procedures in medicine, for example, should not be done by untrained personnel (legal constraints help enforce this rule; but gray zones remain because in Germany, non-medical practitioners – “Heilpraktiker” – are allowed to administer low-level medical interventions). Because CS implies that scientific research is conducted without scientific training, it poses a challenge to all those who work in scientific environments, like universities and academies, where researchers are being educated and trained in specific disciplinary content and methods. Is it really conceivable that nonprofessionals could make valuable contributions to science?

2 Citizen Science: First Clarifications

In this article, I will assess the potential CS holds for my discipline, namely psychology. Before doing so, allow me to discuss my understanding of CS in a broader context. In 2001, the British psychologist Richard Wiseman – who, at the University of Herfordshire, holds Britain's only Professorship for the Public Understanding of Psychology –, started a project called "Laugh Lab" (www.richardwiseman.com/LaughLab): Laugh Lab was an Internet-based collection of jokes from all over the world born out of the intention to learn more about cultural differences in humour. The public was not so much underway as scientists but as collectors of jokes. This was a fancy enterprise but is it CS? To come to a better understanding of CS and its potential role in science it might be helpful to start with a description of science and the different aspects therein. Science in the understanding of "Wissenschaft" (the German word for science, arts, and humanities) comprises natural sciences, social sciences, formal sciences and liberal arts, all of them helping humans to collect (true) knowledge and to better understand the (chaotic) world around us.

What are the tasks of professional scientists? Science can be seen as a cycle beginning with a question and ending with a tentative answer to that question. Going through the phases of this process, we can examine to which extent lay people may contribute to each individual phase. As an empirically oriented psychologist, I take the different steps that empirical research follows as a guideline.

1. *Asking questions.* The starting point of every scientific enterprise is a (more or less) naïve question. To answer simple questions (for example, "where do the colors of the rainbow come from?"), lay people are as qualified as trained scientists to provide an answer; but to answer more detailed questions (for example, "what is the role of the exponent in Stevens' power law?") which require background knowledge about psychophysics, a solid training in psychology is necessary.

2. *Theorizing and hypothesis building.* This is a task which requires training in methodology if hypotheses go beyond simple expectations. Lay persons might find it difficult to fomulate, e.g., a "null hypothesis" that can be statistically tested against an "alternative hypothesis". So, this phase in the scientific process requires some experience and training. Also, decisions

in this phase depend on the chosen "philosophy of science", or to be more precise, the chosen "philosophy of psychology" (Bunge & Ardila, 1987).

3. *Data collection.* This might look like the easiest place to accommodate contributions of non-professionals. Unfortunately, that is not true. If we follow, for example, Sir Karl Popper's advice, we should not search for evidence that verifies our hypothesis but rather for counter-evidence (Taleb, 2007). In addition, it is not always easy to determine the appropriate number of obeservations necessary to reach a reliable conclusion. In psychology, underpowered studies are one of the major sources of the "reproducability crisis" (Simmons, Nelson, & Simonsohn, 2011). Without good knowledge about statistics, one might stop data collection too early.

4. *Data analysis.* For many scientific areas, modern developments in data analysis require sophisticated statistical analyses. Even though there is a debate about the misuse of statistics and the need for "new" statistics (e.g., Cumming, 2014), there can be no doubt that substantial training is needed in order to to properly and adequately run statistical analyses. If statistics is not done properly, a kind of surrogate science will emerge (Gigerenzer & Marewski, 2015). The current distrust in statistics originated from improperly used software. Nearly all statistical software packages would compute nearly everything out of any data set within milliseconds, according to the GIGO principle ("garbage in, garbage out").

5. *Giving answers* (interpretation and evaluation of results). The ability to appropriately interpret results is highly dependent upon experience and therefore extremely difficult for lay people to acquire. Interestingly, many scientific inventions have been new interpretations of erraneous events. For example, Alexander Fleming discovered penicillin in 1928 by accident (a Petri dish had been left open by mistake) but it needed his experience to understand the importance of his mistake; an untrained person might have disposed of the Petri dish. Most results do not "speak" for themselves but need a knowing "translator" to make sense.

Following Haklay (2013), there are four different levels of citizen participation in science: On Level 1 ("crowdsourcing", low CS), a collection of people might set up a funding source for an interesting project that requires citizens to do not much more than just spend money. Take as an example the projects offered on (www.startnext.com/pages/sciencestarter). On Level 2 (“distributed intelligence”, low-to-medium CS), citizens help with their intelligent systems (i.e., their brains and their sensors) to collect and interpret data. To provide another example of CS taken from the field of ethology, see the internet platform www.chimpandsee.org. In this project, volunteer participants watch videos taken by various camera traps in Africa and code the behavior of chimpanzees and other animals. By doing this, participants help professional researchers learn more about both the environment and human evolution. On Level 3 (“participatory science”, medium-to-strong CS), citizens contribute to problem definition and data collection. Take as an example the ornithology project described by Wink (2015; see also Wink, this volume) that consisted of a field mapping of birds in the German “Rheinland” region. Started in the mid-1980s with the help of untrained enthusiasts, bird-mapping is now a broad international movement (see www.ornitho.de or www.bto.org). On Level 4 (“extreme citizen science”, strong CS), citizens closely collaborate with scientists to define problems, collect data, and analyze data. In this case, citizens might even end up becoming co-authors of scientific publications.

CS is defined as “scientific research conducted, in whole or in part, by amateur or nonprofessional scientists” (Wikipedia). From my point of view, this narrow definition of CS could be enriched by a broader understanding that views citizens not only as workers for science but also as initiators and recipients of science: In this understanding, citizens play an active role in formulating research questions and participate in discussions about the use of scientific knowledge. CS is thus part of a larger movement that falls under the label of “public participation in scientific research” (PPSR).

3 Citizen Science in the Field of Psychology

Psychology differentiates between basic research areas like biological, cognitive, developmental, personality, or social psychology and different areas of applied research. The most prominent areas of application are clinical, organisational, and educational psychology. Again, I will evaluate the potential of CS separately for each of these areas.

CS in clinical psychology. The treatment of psychic illnesses is for good reasons restricted to highly qualified therapists. A licensed psychotherapist should know about potential errors in treatment, thus, patients can be relatively sure not to be malpracticed. But there is a broad field of care that is provided by non-medical practitioners and does not deserve the label of treatment. I would not label that kind of care CS either because these practitioners have received training and are not pure amateurs. A big chance for CS in therapy and especially in aftercare comes from support groups like Alcoholics Anonymous. Here, talks and discussions with “peers” help prevent relapse. So, untrained persons and former patients are able to support patients with similar experiences by sharing information and by giving social support. In a sense, this might not be considered science so much as practical application; but there is always applied science (as in the case of physics, where engineers translate basic research knowledge into applications), and the applied scientist is still a scientist.

CS in organisational psychology. Trade-unions collect knowledge about improving work flow processes. Trade-unions were also driving the process of co-determination that can be seen as an empowerment of workers and citizens alike. And finally, the process of “humanisation of work” (that was the label of a huge governmental research programme in Germany that started in the 1970s) was not primarily driven by scientific psychological theories. This revolution was inspired by fresh ideas from persons outside of science how to make the workplace a better working environment. Even today, new ideas for changing the way work is organised do primarily not stem from organisational psychologists but from politicians, as can be seen, for example, in the case of Frederic Laloux and his inspiring book “Reinventing organizations” (Laloux, 2014).

CS in educational psychology. In educational contexts, non-professionals tutor pupils and students. But this is more application of research than basic research itself. Science education might be a more important issue for educational psychology: how to teach the need for and meaning of good science to a broader audience. Collins (2015) provides some examples for this area.

CS in basic psychological research. Applications of basic psychological research could involve tagging images or transcribing think-aloud protocols, to mention just two examples of tasks that could easily be taken over by volunteers. But to be honest: the more basic the research the more difficult to catch all the theories and data from previous research. It was much easier in the 19th century when the journalist and toymaker Charles Benham, for example, presented “Benham’s top”, a disk that when spun produces pattern-induced flicker colors. Even today, this perceptual phenomenon is not completely understood (for an online demo, see www.michaelbach.de/ot/col-Benham/). It would not be so easy for an amateur psychologist to introduce a new phenomenon into our science today.

Currently, there are not many applications of psychology that feature a CS background. But the chances are high that the state of affairs might change soon enough. With the advent of Open Science, a broader interest in psychological issues might have surfaced. Potentials could be seen, for example, in the psychologically motivated analyses of diaries. Large bodies of data already exist, like war diaries from WW1 (see www.operationwardiary.org). These diaries could be analysed with respect to emotions (i.e., whether the authors felt anger or fear) and coping styles (i.e., how the authors responded to thread situations). In addition, large public data sources are available in the area of computer games where live streaming offers a new approach for cognitive psychology (Wendt, 2017).

4 On the Psychology of Citizen Science

There is another aspect of CS that is of relevance, namely that of the motivation of a person to engage in CS. In the public domain, there is a long tradition of volunteerism, e.g., in the area of fire fighting (see, e.g., McLennan, Birch, Cowlishaw, & Hayes, 2009). Concerning the motivation of, e.g., bee watchers, it turned out that learning about the subject at hand was the most important driver of behavior, followed by wanting to contribute to scientific research and to help the environment (Domroese & Johnson, 2017). How to design programmes and platforms for successful CS projects in order to attract and retain volunteer scientists is also an important issue (Wald, Longo, & Dobell, 2016). It is important to keep volunteers actively involved for longer timer periods, especially with trained volunteers.

With the "Volunteer Functions Inventory" (VFI), an assessment instrument exists that can be used to measure the following six different functions (following the descriptions from Clary & Snyder, 1999, p. 157): (1) Values: the individual volunteers participate in order to express or act on important values like humanitarianism; (2) Understanding: the volunteer is seeking to learn more about the world or to exercise skills that are often unused; (3) Enhancement: one can grow and develop psychologically through volunteer activities; (4) Career: the volunteer has the goal of gaining career-related experience through volunteering; (5) Social:

volunteering allows an individual to strengthen his or her social relationships; (6) Protective: the individual uses volunteering to reduce negative feelings, such as guilt, or to address personal problems.

With a slightly modified version of the VFI, called "Environmental Volunteer Functions Inventory" (EVFI), the following five dimensions could be extracted (according to Wright, Underhill, Keene, & Knight, 2015, p. 1023): "(1) recreation/nature-based, (2) personal values, (3) personal growth, (4) social interactions, and (5) project organization". These different kinds of motivation help to better understand and mobilize volunteers for CS projects.

To give an CS example from the huge field of medicine: On www.patientslikeme .com (which also features a German extension: www.teilnehmen.redensiemit.org), more than 500.000 users who report suffering from chronic health conditions get together and share their experiences living with disease. The sheer number of participants indicates a strong interest in this type of sharing experience and knowledge.

5 Comparing Chances and Risks of Citizen Science in Psychology

In this section, I will compare the chances and risks associated with CS in the context of psychological research. Instead of using checklists that mark the advantages or disadvantages of CS, I will present some general issues that play a role in the development of CS. These more general issues relate to the quality of data, the fast growing communities, the choice of themes, or the consequences of increased interdisciplinarity. The rhetorics of participation are not the focus of this paper but one should also be aware of political framing effects in this field of research (Lakoff & Wehling, 2012).

Quality of data. In a recent paper, Sochat et al. (2016) proposed the use of pre-defined, standardized experimental setups (i.e., the running of experiments can be done by other persons than those responsible for the setup) and of volunteers from a participant pool registered at Amazon Mechanical Turk (www.mturk.com). These "volunteers" receive small financial rewards for participation in experiments run by psychologists. This makes it difficult to call that activity CS: If people get paid for participation in an experiment, these incentives might have effects on the quality of data – higher incentives could potentially increase the carefulness and attention of subjects, thus influencing the results of such studies.

Fast growing communities. The commercially oriented movement "Quantified Self" (www.quantifiedself.com) promotes data collection about individiual behavior. According to their homepage, their "mission is to support new discoveries about ourselves and our communities that are grounded in accurate observation and enlivened by a spirit of friendship". It addresses primarily health data. The non-commercial group of "Participatory Medicine" (www.participatorymedicine.org) represents – according to their homepage – "a movement in which networked patients shift from being mere passengers to responsible drivers of their health, and in which providers encourage and value them as full partners."

Concentration on "useful" research. A danger for a broad coverage of research themes might be seen in the issue of assumed "utility" of research. Lay people might be more driven by practical issues and more likely to look for research that has usable outcomes. But basic science is driven by curiosity, not by utility. There is a nice paper by Abraham Flexner (1939), founder of the Institute for Advanced Study in Princeton, who examines the "usefulness of useless knowledge". His final conclusion (by looking back to the history of science) is very simple: "we cherish the hope that the unobstructed pursuit of useless knowledge will prove to have consequences in the future as in the past" (p. 552).

Consequences of increased interdisciplinarity. The more scientific activities are done in an interdisciplinary context, the more the boundaries between trained and untrained scientists vanish: As soon as one leaves the small comfort zone of one own's expertise, one may become an amateur in another area. When a psychologist and a neurologist collaborate to develop neuroimaging techniques it must be clear that in such a tandem, the psychologist is lacking expertise about the neurological aspects of the project (while the neurologist is naïve about the psychological aspects). The advantage of crossing such frontiers is the birth of fresh ideas that are not constrained by a *déformation professionelle* (a French phrase for job conditioning). Many inspiring ideas have come from people who did not work in the field they made an interesting observation about. Take as an example the Flynn effect (a secular rise in IQ points, see Pietschnig & Voracek, 2015) that was introduced into psychology by a political scientist (Flynn, 1987).

Sharing knowledge. Nowadays, sharing knowledge has become easy. The internet offers a broad spectrum of publication possibilities with different degrees of quality control. One of the most exiting examples is the Wikipedia (WP) Initiative that started in 2001 with the help of Jimmy Wales and Larry Singer. The concept of an online encyclopedia without central control that offers every person on this planet an opportunity to distribute her or his expert knowledge is now used by more than 500 million readers monthly. Most of the WP contributors do not have an academic background. Within the academic psychology community in Germany, this missing academic basis of WP entries has provoked a call for more active participation and cooperation between scientists and citizens (Funke & Fahrenberg, 2016). In a sense, WP is a project that fulfills the criteria of CS. But once again, quality control is an issue for this enterprise.

To summarize: CS is only slowly gaining more traction in psychology. The gap between citizens and scientists that has led to a postfactual society might be reduced by more cooperation between both sides. Participatory educational research, for example, might help to reduce misunderstanding and emotional debates in the context of educational assessments like PISA. As Gollwitzer et al. (2014) wrote:

> Participatory educational research could not only increase the acceptance of research itself, but also help to decrease the imagined threat of social identity. If teachers are accepted by educational researchers as experts for practical issues, then better conditions arise that allow for an open-minded discussion and evaluation of research results. Only then it is possible to positively develop changes in the education system in a broad consensus that are based on solid scientific research. (p. 113; translated by J.F.)

6 Final Remarks

Psychological science and science in general are currently under pressure due to problems with the reproducability of results (Munafò et al., 2017; Open Science Collaboration, 2015). The "Open Science Foundation" (OSF; see www.osf.io) represents a growing community of researchers committed to making the complete scientific process transparent. This ensures reproducability not only by making material and data accessible to third parties, but by allowing others to shape and support research projects from their inception.

Connecting psychology and society has been an issue for many years. The famous presidential address from George Miller (1969), former president of the "American Psychological Association" (APA), coined the term "to give psychology away" – which was an order to all psychologists to care for the welfare of mankind. But the connection between psychology and society is not a one-directional; there is a back-channel. Citizens may serve as data collectors, as sensors, as observers - there are many roles engaged and motivated citizens can take over in order to improve psychological science.

In a more general sense, CS can be seen as a "paradigm shift" sensu Kuhn (1962): The role of trained scientist as gate keepers for publications within the scientific peer review process and – more general – as guardians of theories, methods, and data is changing. Scientists are loosing power and have to gain respect by other means than counting their publications, showing their "h-index" (Ruscio, 2016), or writing papers that only a small community of likeminded colleagues would understand. They would gain respect again by making predictions that have a higher entrance probability than today's prediction of elections or of economic developments; they would gain respect by understandably communicating science to interested lay people and by explaining the world around us through state-of-the-art explanations for climate change, vaccination, and other controversial themes; in one word: they would gain respect by making science for citizens.

Acknowledgements Thanks to Julia Karl for helpful comments on an earlier version of this manuscript, thanks to Julia Nolte for carefully revising my manuscript with respect to English language.

References

Beck, U. (2009). *World at risk*. Cambridge, UK: Polity Press.

Bunge, M., & Ardila, R. (1987). *Philosophy of psychology*. New York: Springer.

Clary, E. G., & Snyder, M. (1999). The motivations to volunteer. *Current Directions in Psychological Science*, *8*(5), 156–159. http://doi.org/10.1111/1467-8721.00037

Collins, H. (2015). Can we teach people what science is really like? *Science Education*, *99*(6), 1049–1054. http://doi.org/10.1002/sce.21189

Cumming, G. (2014). The new statistics: Why and how. *Psychological Science*, *25*(1), 7–29. http://doi.org/10.1177/0956797613504966

Domroese, M. C., & Johnson, E. A. (2017). Why watch bees? Motivations of citizen science volunteers in the Great Pollinator Project. *Biological Conservation*, *208*, 40–47. http://doi.org/10.1016/j.biocon.2016.08.020

Flexner, A. (1939). The usefulness of useless knowledge. *Harpers*, *179*, 544–552. http://doi.org/10.1111/j.1540-6563.1960.tb01656.x

Flynn, J. R. (1987). Massive IQ gains in 14 nations: What IQ tests really measure. *Psychological Bulletin*, *101*(2), 171–191. http://doi.org/10.1037/h0090408

Funke, J., & Fahrenberg, J. (2016). Wikipedia: Eine sinnvolle Aufgabe für akademisch Tätige - Ein Aufruf zur Mitarbeit. *Psychologische Rundschau*, 32–33.

Gigerenzer, G., & Marewski, J. N. (2015). Surrogate science: The idol of a universal method for scientific inference. *Journal of Management*, *41*(2), 421–440. http://doi.org/10.1177/0149206314547522

Gollwitzer, M., Rothmund, T., Klimmt, C., Nauroth, P., & Bender, J. (2014). Gründe und Konsequenzen einer verzerrten Darstellung und Wahrnehmung sozialwissenschaftlicher Forschungsbefunde: Das Beispiel der „Killerspiele-Debatte". *Zeitschrift Für Erziehungswissenschaftliche Forschung*, *17*, 101–117. http://doi.org/10.1007/s11618-014-0511-8

Haklay, M. (2013). Citizen science and volunteered geographic information: Overview and typology of participation. In D. Sui, S. Elwood, & M. Goodchild (Eds.), *Crowdsourcing geographic knowledge: Volunteered geographic information (VGI) in theory and practice.* Dordrecht: Springer. http://doi.org/10.1007/978-94-007-4587-2_7

Irwin, A. (1995). *Citizen Science: A study of people, expertise and sustainable development*. London: Routledge.

Kuhn, T. (1962). *The structure of scientific revolutions*. Chicago, IL: University of Chicago Press.

Lakoff, G., & Wehling, E. (2012). *The little blue book: The essential guide to thinking and talking Democratic.* New York: Simon & Schuster.

Laloux, F. (2014). *Reinventing organizations: A guide to creating organizations inspired by the next stage of human consciousness.* Brussels: Nelson Parker. http://doi.org/Kindle

League of European Research Universities (2016). *Citizen science at universities: Trends, guidelines and recommendations.* Leuven.

McLennan, J., Birch, A., Cowlishaw, S., & Hayes, P. (2009). Maintaining volunteer firefighter numbers: Adding value to the retention coin. *Australian Journal of Emergency Management*, *24*(2), 40–47.

Miller, G. A. (1969). Psychology as a means of promoting human welfare. *American Psychologist*, *24*(12), 1063–1075. http://doi.org/10.1017/CBO9781107415324.004

Munafò, M. R., Nosek, B. A., Bishop, D. V. M., Button, K. S., Chambers, C. D., Percie, N., . . . Wagenmakers, E.-J. (2017). A manifesto for reproducible science. *Nature Human Behaviour*, *1*(21), 1–9. http://doi.org/10.1038/s41562-016-0021

Open Science Collaboration. (2015). Estimating the reproducibility of psychological science. *Science*, *349*(6251), aac4716-aac4716. http://doi.org/10.1126/science.aac4716

Pietschnig, J., & Voracek, M. (2015). One century of global IQ gains: A formal meta-analysis of the Flynn effect (1909-2013). *Perspectives on Psychological Science*, *10*(3), 282–306. http://doi.org/10.1177/1745691615577701

Ruscio, J. (2016). Taking advantage of citation measures of scholarly impact: Hip hip h index! *Perspectives on Psychological Science*, *11*(6), 905–908. http://doi.org/10.1177/1745691616664436

Simmons, J. P., Nelson, L. D., & Simonsohn, U. (2011). False-positive psychology: Undisclosed flexibility in data collection and analysis allows presenting anything as significant. *Psychological Science*, *22*(11), 1359–1366. http://doi.org/10.1177/0956797611417632

Sochat, V. V., Eisenberg, I. W., Enkavi, A. Z., Li, J., Bissett, P. G., & Poldrack, R. A. (2016). The experiment factory: Standardizing behavioral experiments. *Frontiers in Psychology*, *7*(610), 1–9. http://doi.org/10.3389/fpsyg.2016.00610

Taleb, N. N. (2007). *The black swan: The impact of the highly improbable.* New York: Random House.

Wald, D. M., Longo, J., & Dobell, A. R. (2016). Design principles for engaging and retaining virtual citizen scientists. *Conservation Biology*, *30*(3), 562–570. http://doi.org/10.1111/cobi.12627

Wendt, A. N. (2017). The empirical potential of Live Streaming beyond cognitive psychology. *Journal of Dynamic Decision Making*, *3*(1), 1–9. http://doi.org/10.11588/jddm.2017.1.33724

Wink, M. (2015). Bürgerforschergruppen. In P. Finke (Ed.), *Freie Bürger, freie Forschung* (pp. 40–44). München: oekom.

Wissenschaftsrat (2015). *Zum wissenschaftspolitischen Diskurs über Große gesellschaftliche Herausforderungen*. Berlin.

Wright, D. R., Underhill, L. G., Keene, M., & Knight, A. T. (2015). Understanding the motivations and satisfactions of volunteers to improve the effectiveness of citizen science programs. *Society & Natural Resources*, *28*(9), 1013–1029. http://doi.org/10.1080/08941920.2015.1054976

About the Author

Prof. Dr. Dr. h.c. Joachim Funke studied philosophy, German culture, and psychology at the universities of Düsseldorf, Basel, and Trier. Doctoral degree 1984 at Bonn University, Habilitation 1990 at Bonn University. Honorary doctorate 2015 at Szeged University, Hungary. Since 1997, he is full professor for Cognitive and Experimental Psychology at Heidelberg University. His research interests are thinking and intelligence, creativity and problem solving. He is author and coauthor, editor and coeditor of more than 15 books and has authored and coauthored many journal publications. Since 2010, he is spokesman of the Academic Senate of Heidelberg University. From 2009 until 2014, he was chairman of the international "PISA Problem Solving Expert Group" from the OECD.

Correspondence:
Prof. Dr. Dr. h.c. Joachim Funke (ORCID ID: 0000-0001-9129-2659)
University of Heidelberg
Department of Psychology
Hauptstr. 47–51
69117 Heidelberg
E-Mail: joachim.funke@psychologie.uni-heidelberg.de
Homepage: (www.funke.uni-hd.de)